OTTER CREEK ENGINEERING

November 8, 2023

Mr. Stan Wilbur, Town Administrator
Town of Monkton, Vermont
townadministrator@monktonvt.com

Via Email

Subject: Tyler Bridge Road – Project Scoping
Early Concepts and Estimates

Dear Stan and Selectboard Members:

This letter outlines the early concept planning and cost estimates associated with the replacement of the existing culvert below Tyler Bridge Road in Monkton.

We understand that the Town is working proactively to plan for the replacement of the existing corrugated metal pipe (cmp) that conveys Pond Brook beneath Tyler Bridge Road in Monkton, refer to location map attached. As part of the planning, the Town has contracted with Otter Creek Engineering (OCE) to help develop early concept options and costs which will inform the Town in its decision making and funding approach.

As part of the initial investigations, OCE has referred to an existing Vermont Agency of Transportation (VTrans) Hydraulic Memorandum identifying recommendations and design parameters for a replacement culvert. The memorandum concluded that the existing culvert does not meet current VTrans Hydraulic Manual requirements for flow capacity. In addition, the existing culvert does not comply with State Stream Alteration Standards for aquatic organism passage. A replacement structure should be designed to comply with VTrans and Agency of Natural Resource standards. OCE anticipates that work to replace the existing culvert will trigger the need to obtain State Stream Alteration, Army Corps Wetland, and State Wetland Permits.

Otter Creek Engineering's approach to the project was to first meet with State River Management Engineer, Jaron Borg, to obtain confirmation of the bank full width for the replacement structure. The bank full width as determined by Jaron for this portion of Pond Brook is 24 feet and this is the minimum width required for a replacement structure to satisfy the State Stream Alteration Permit requirements for aquatic organism passage.

Concurrent with our meeting with Jaron, OCE took the opportunity to gather and document existing site conditions. We performed field measurements and determined the existing squashed corrugated metal pipe to be approximately 174-inch in width. The existing culvert has approximately three feet of material over the top. We noted that the existing culvert constricts the channel width increasing the potential for debris blockage. Otter Creek Engineering also obtained estimated dimensions of the existing culvert and road to be used for proposed condition sketches.

Otter Creek Engineering used the determination of Bank Full Width, existing conditions information, and VTrans Hydraulics Memo recommendations to establish four replacement options: A Pre-Cast Box Culvert, a Pre-Cast Arch Culvert, a Pre-Cast Plank Bridge, and an Aluminum arch culvert.

Each option was reviewed for cost and is provided with comments/considerations related to constructability and schedule.

The first option considered was for a Pre-Cast Concrete Box Culvert. This option was ruled out because of manufacturing limitations. Boxes with clear openings of more than 20 feet are not generally feasible to construct and pose other concerns such as hauling weight across roadways, the need for a much larger crane to perform the work, and an added level of difficulty to assemble heavy pieces of piping. OCE is not aware of a manufacturer in Vermont or New Hampshire that has the ability to produce a pre-cast concrete box culvert with a 24-foot span. For these reasons, OCE has not performed a cost analysis of this option.

OCE next reviewed the option for a Pre-Cast Arch Culvert. Pre-cast arch culverts with spans of 24 feet or more are routinely manufactured and available. Based on initial review, an arch culvert with a 28'-11" span and 8'6" rise would be appropriate for the crossing. Note that the wider span is necessary to account for the arching of the culvert as the bottom portion of the arch is buried to account for frost protection. A precast arch would require a cast-in place concrete footing that would need to be designed by a structural engineer following geotechnical testing. An arch culvert would meet requirements for both hydraulics and aquatic organism passage. Attached are early concept sketches showing approximate layout and structure dimensions. Early conceptual cost estimate for an arch culvert is anticipated to be $791,000. The price includes a 15% contingency and does not include engineering, permitting and construction oversight. Concrete arch allows for a natural channel bottom and concrete provides long term durability. For comparison, the precast arch sections are heavier and larger than the components associated with the precast concrete plank option discussed below.

The third option considered for the replacement of the existing culvert is for a precast concrete plank bridge. This option is almost identical to what was recently implemented for the Town's project on Mountain Road. OCE has found that this type of plank/bridge system offers more ease for installation as the planks used are by comparison less weight than those for an arch. Another consideration is availability. Planks can be manufactured locally at a lesser cost. In addition, fabrication of planks can occur on a faster timeline than that of an arch. For a span of 28 feet, a plank system is estimated to cost $611,000. Note that a longer span is identified to allow for armoring of the foundation walls and to provide frost protection on the bridge footings. A plank-style bridge would require cast-in-place footings and design by a structural engineer following geotechnical investigations. A sketch, attached, shows approximate dimensions for a precast concrete plank bridge. This option would meet requirements for hydraulics and stream alteration/aquatic organism passage. Pricing includes a 15% contingency and does not include engineering, permitting and construction oversight.

The fourth and final option considered for the replacement of the existing culvert is an aluminum arch culvert. OCE obtained a preliminary estimate from a manufacturer for an aluminum arch culvert with Steel Express Foundations. Based on this preliminary estimate a 31'-5" aluminum arch culvert was identified to be appropriate for the crossing with an estimated cost of $756,000. Note that a longer span is identified to allow for armoring of the foundation walls and to accommodate the required hydraulic capacity of the waterway. Pricing includes a 15% contingency and does not include engineering, permitting, and construction oversight. A sketch, attached, shows the approximate dimensions of the aluminum arch culvert. This option will meet the hydraulic and stream alteration/aquatic organisms passage requirements. An aluminum arch culvert is slightly less expensive in comparison to a pre-cast-arch culvert but does not provide the same durability. The metal is less durable than concrete.

OCE suggests as part of its decision process that the town review and consider the necessary design, permit, and construction oversight costs as they relate to overall costs and funding. The design, permitting and construction costs across all options can be considered roughly equivalent for planning purposes. However, these costs vary based on whether the project is self-funded or if the project is developed through a VTrans program such as the Municipal Assistance Bureau (MAB). Additionally, funding programs play a role in the material and construction costs. The estimates provided above are based on the presumption that the Town will perform the work as part of its general procurement process. Should VTrans funding through Municipal Assistance Bureau (MAB) or other similar program be used, we recommend revisiting the construction costs provided.

Based on our experience and the options considered above and based on cost, OCE's recommendation is that the Town proceed with the precast concrete plank option for the replacement of the crossing at Tyler Bridge Road. This is based on overall cost as well as our experience with construction of each of these types of structures.

We would be happy to meet with the Town to review and discuss pricing and the merits of each option provided above in more detail, if requested. We thank you for the opportunity to continue to assist the Town of Monkton with its engineering needs.

Sincerely,

Brent F. Rakowski, P.E.
Vice President

Enc.

VERMONT

Location Map - Tyler Bridge Road Culvert

Vermont Agency of Natural Resources

vermont.gov

LEGEND

- Bridges
- Culvert
- Parcels (standardized)
- Roads
  - Interstate
  - US Highway; 1
  - State Highway
  - Town Highway (Class 1)
  - Town Highway (Class 2,3)
  - Town Highway (Class 4)
  - State Forest Trail
  - National Forest Trail
  - Legal Trail
  - Private Road/Driveway
  - Proposed Roads
- Town Boundary

NOTES

Map created using ANR's Natural Resources Atlas

522.0 0 261.00 522.0 Feet

WGS_1984_Web_Mercator_Auxiliary_Sphere 1" = 261 Ft. 1cm = 31 Meters

THIS MAP IS NOT TO BE USED FOR NAVIGATION

VERMONT

VTRANS HYDRAULIC MEMO

State of Vermont
Structures and Hydraulics Section
Barre City Place
219 North Main Street | Barre, VT 05641
vtrans.vermont.gov

Agency of Transportation

[phone] 802-371-7326
[fax] 802-828-3566
[ttd] 800-253-0191

TO: Alysha Kane, District 5 Project Manager

CC: Jaron Borg, ANR River Management Engineer

FROM: Keith Friedland, Hydraulics Technician

DATE: May 18, 2023

SUBJECT: Monkton, TH-6, Tyler Bridge Road, over Pond Brook tributary to Lewis Creek
Site location: 0.3 miles north of TH-4, States Prison Hollow Road
Coordinates: 44.261694, -73.098806

We have completed our hydraulic study for the above referenced site and offer the following for your use. The drainage area and structure size recommended are both large enough that when a survey of the site becomes available, a more detailed model and site design should be developed for this structure.

Hydrology

The following physical characteristics are descriptive of this drainage basin:

Drainage Area	16.0 square miles
Land Cover	Forest, fields wetlands and residential areas
Water Bodies and Wetlands (NLCD 2006)	17.9 %

Using the USGS hydrologic method, the following design flow rates were selected:

Annual Exceedance Probability (AEP)	Flow Rate in Cubic Feet per Second (cfs)	
50 % (Q2)	260	
10 % (Q10)	510	
4 % (Q25)	660	Design Flow – Local Road
2 % (Q50)	780	
1 % (Q100)	910	Check Flow

Channel Morphology

The channel for this perennial stream is sinuous to meandering with an estimated local channel slope of 0.3%. Field measurements of bankfull width varied from 18 to 22 feet at a bankfull depth of 2 to 4 feet upstream and downstream of the structure.

Existing Conditions

The existing structure is a corrugated metal pipe arch with an approximate clear span of 12 feet and a clear height of 8 feet, providing an approximate waterway opening of 75 square feet. Our calculations, field observations and measurements indicate the existing structure does not meet the requirements of the VTrans Hydraulic Manual

nor does the existing structure meet state stream equilibrium standards for bankfull width (span length). The existing structure constricts the channel width, resulting in an increased potential for debris blockage. This complication is known to cause ponding at the inlet, increase stream velocity and scour at the outlet, and may lead to erosion and failure of channel banks.

This structure results in a headwater depth of approximately 9.3 feet at 4% AEP with water overtopping the roadway before the 2% AEP.

Replacement Recommendations

In sizing a new structure, we attempt to select structures that meet both the current VTrans hydraulic standards, state environmental standards with regard to span length and opening height, and consider roadway grade and other site constraints.

The low height from the streambed to the road might limit the replacement options to the bridge or concrete box structure, as the roadway may have to be raised for the open bottom arch. Pipe manufacturers can provide specific recommendations regarding minimum and maximum fill heights and required pipe thickness.

Based on the above considerations and the information available, we recommend any of the following structures as a replacement at this site:

- A concrete slab bridge with a clear span of 20 feet and clear height of 8 feet, providing 160 square feet of waterway area. The bottom of abutment footings should be at least 6 feet below the channel bottom, or to ledge, to prevent undermining. This structure results in a headwater depth of 5.6 feet at the 4% AEP and 7.0 feet at the 1% AEP. *This structure provides 2.4 feet of freeboard at the design AEP.*

- An open bottom arch with a minimum clear span of 23 feet and clear height of 8 feet, providing a waterway area of 134 square feet. The bottom of abutment footings should be at least 6 feet below the channel bottom, or to ledge, to prevent undermining. This structure results in a headwater depth of 6.0 feet at 4% AEP and 7.5 feet at 1% AEP. *This structure provides 2.0 feet of freeboard at the design AEP.*

- A concrete box with an inside opening span of 20 feet and minimum height of 8.5 feet. The box invert should be buried 1.5 feet. This will result in a clear height of 7 feet above streambed, providing 140 square feet of waterway area. Bed retention sills should be added in the bottom of the structure. Sills should be 12 inches high at the edges of the box and 6 inches high in the center, creating a V-shape across the full width of the box. Sills should be spaced no more than 8 feet apart throughout the structure with one sill placed at both the inlet and the outlet. The structure should be filled level to the streambed with E-Stone, Type I, allowing flow to be kept above the surface, providing the conditions necessary for aquatic organism passage. This structure results in a headwater depth of 5.7 feet at the 4% AEP and 7.0 feet at the 1% AEP.

Note: *Any similar structure that fits the site conditions could be considered. Any structure with a closed bottom should have bed retention sills and a buried invert as described above. If an open bottom structure is installed, the VTrans Hydraulics Manual requires a minimum of 1-foot of freeboard at the design AEP.*

To match the approximate local stream slope, the structures recommended above have been modeled with a culvert slope of 0.3%. **The local stream slope should be verified prior to installation of the new structure.**

Stone Fill, Type II should be used to protect any disturbed channel banks or roadway slopes at the structure's inlet and outlet, up to a height of at least one-foot above the top of the opening. The stone fill should not constrict the channel or structure opening.

Prior to any action toward the implementation of any recommendations received from VTrans, stream type and structure size must be confirmed, and may be modified, by the VT ANR River Management Engineer to ensure compliance with state environmental standards for stream crossing structures. This structure is within the mapped FEMA flood insurance study floodplain.

General Comments

It is always desirable for a new structure to have flared wingwalls, matched into the channel banks at the inlet and outlet, to smoothly transition flow and protect the structure and roadway approaches from erosion. It is also recommended that full height concrete headwalls be constructed at the inlet and outlet. Any closed bottom structure should also be equipped with cutoff walls, extending to a depth equal to the culvert rise, up to 4 feet, or to ledge, to serve as undermining prevention. E-Stone thickness plus the bottom of structure thickness should be included when determining the total cutoff wall depth.

If a new bridge is installed, the bottom of abutment footings should be at least 6 feet below the channel bottom, or to ledge, to prevent undermining. Abutments on piles should be designed to be free standing for a scour depth at least 6 feet below channel bottom.

Any new structure should be properly aligned with the channel, span the natural channel width, and be constructed on a grade that matches the channel.

The structures recommended above have been sized with respect to hydraulic and environmental standards and do not consider debris blockage complications. To minimize maintenance and ensure constructability, it is recommended that the structure height be adequate for installation of E-Stone and passage of debris.

Please note that while a site visit was made, these recommendations were made without the benefit of a survey and are based on limited information. The final decision regarding replacement of this structure must comply with state regulatory standards, and should take into consideration matching natural channel conditions, roadway grade, environmental concerns, safety, and other requirements.

Please contact us if you have any questions or if we may be of further assistance. **We can always check other options if the town settles on something not noted above.**

TOWN OF MONKTON, VERMONT

TYLER BRIDGE ROAD CULVERT REPLACEMENT - CONCRETE ARCH CULVERT

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

November 6, 2023

OTTER CREEK ENGINEERING

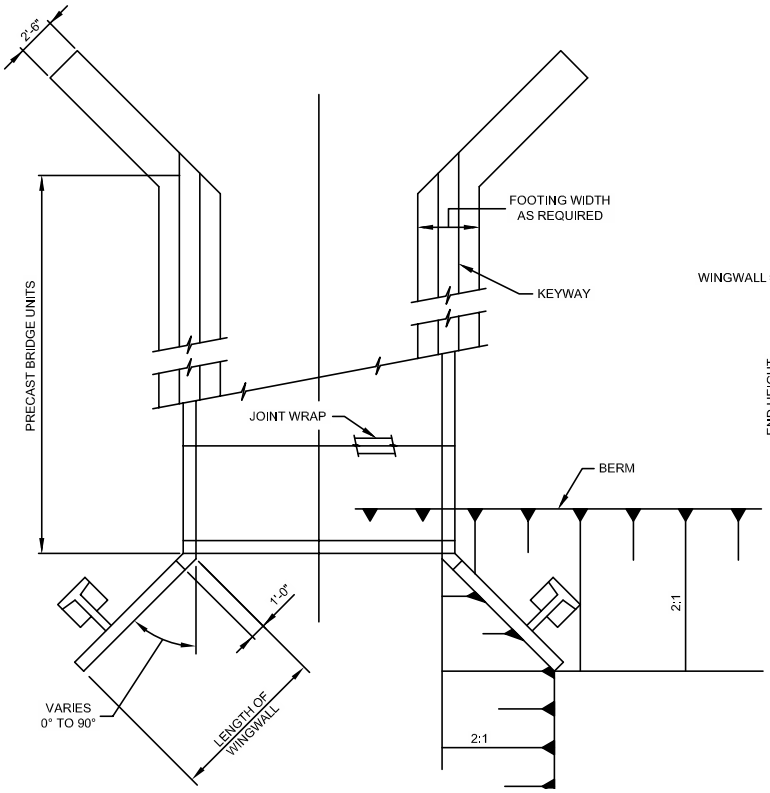
Item No.	Description	Unit	Est. Qty.	Cost/Unit	Total Cost
1.	**Contract General Conditions**				
	General Conditions (Bonds Insurance)	L.S.	1	$50,000.00	$50,000
	Erosion Control/ Silt Fencing/Maintenance	L.S.	1	$6,000.00	$6,000
	Traffic Control / Signs, Barracades, etc.	L.S.	1	$4,000.00	$4,000
	Mobilization and Demobilization	L.S.	1	$ 35,000.00	$35,000
			Contract General Conditions Subtotal =		**$95,000**
2.	**Culvert Replacement**				
	Excavation, haul unsuitable offsite	C.Y.	1,550	$ 45.00	$69,750
	Bypass pump, divert flows	WK	4	$ 2,500.00	$10,000
	Disassemble and remove existing culvert	Hr.	6	$ 350.00	$2,100
	1 1/2-inch crushed stone bedding	C.Y.	150	$ 50.00	$7,500
	Cast in place concrete footings w/reinforcing	C.Y.	200	$400	$80,000
	Crane	LS	1	$ 24,000.00	$24,000
	325, Labor install arch culvert	LS	1	$ 30,000.00	$30,000
	Precast Concrete Culvert and wing walls	EA.	1	$ 220,000.00	$220,000
	Streambed Stone Type E2 Against Footings and Interior Walls	C.Y.	150	$ 70.00	$10,500
	Native Backfill Material (inside culvert)	C.Y.	60	$ 40.00	$2,400
	Field Grouting	L.S.	1	$ 8,000.00	$8,000
	Water Proofing	LS	1	$ 8,000.00	$8,000
	ENVELOPE	C.Y.	320	$ 50.00	$16,000
	Filter fabric	RL	3	$ 1,000.00	$3,000
	Embankment material	C.Y.	1,000	$ 45.00	$45,000
	Dense Graded Crushed Stone (Road Base)	C.Y.	170	$ 55.00	$9,350
	Surface Crushed Gravel (Road Base)	C.Y.	60	$ 55.00	$3,300
	Bituminous Paving (base and top)	Ton	55	$ 300.00	$16,500
	Guardrail	L.F.	100	$65	$6,500
	Restoration of Surfaces	S.F.	4,000	$ 2.50	$10,000
			Culvert Replacement Subtotal =		**$582,000**
3	**Earthwork**				
	Rock Excavation	C.Y.	20	$ 250.00	$5,000
	Additional Excavation Below Subgrade	C.Y.	25	$ 45.00	$1,125
	Additional Rip-rap	C.Y.	25	$ 70.00	$1,750
	Additional 1 1/2-inch Crushed Stone Bedding	C.Y.	35	$ 50.00	$1,750
	Miscellaneous Excavation and Backfill	C.Y.	20	$ 70.00	$1,400
			Earthwork Subtotal =		**$11,000**
				Subtotal =	**$688,000**
				+ Contingency (15%) =	$103,000
				TOTAL OPINION OF PROBABLE CONSTRUCTION COST =	**$791,000**

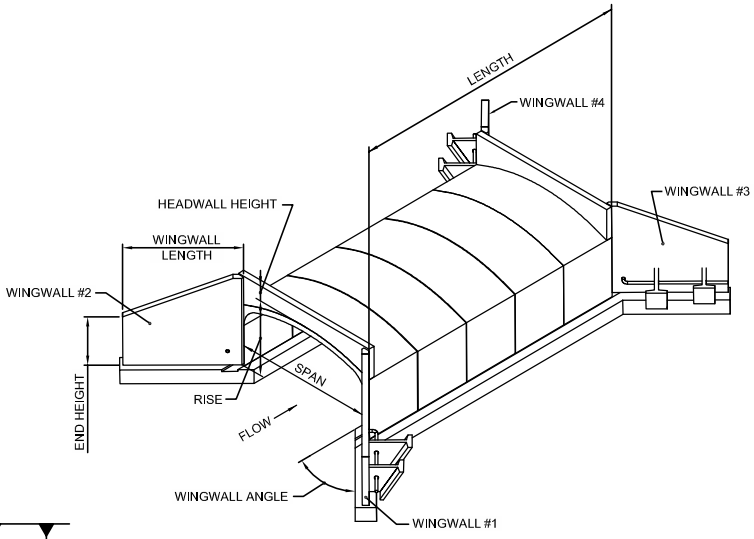
Notes:

1- This estimate has been prepared for the Town's use in project budget planning.
2- Subtotal amounts have been rounded to the nearest $1,000.
3- Overall anticipated project cost has been rounded to the nearest $1,000.
4- Anticipated costs have been developed without a formal survey or final design and are based on a site visit and field measurements by Otter Creek Engineering, Inc.
5- In situ soil conditions have not been evaluated. Foundations based on presumed dimensions of similar sized structures and soil conditions.
6- Unit pricing is based on similar recent projects and discussions with suppliers/manufacturers.
7- Legal, engineering, and permitting costs have not been included.

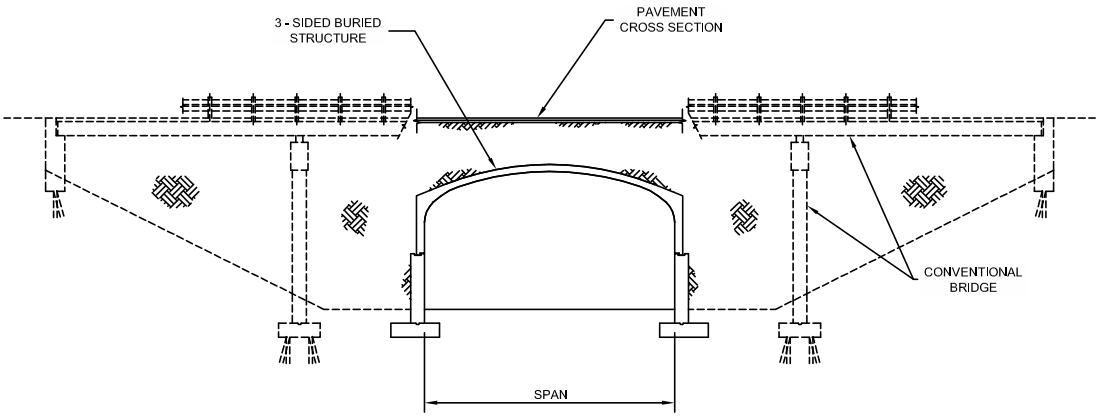
CONTECH®
ENGINEERED SOLUTIONS

Precast Details





Buried Structure vs. Bridge-at-Grade



DESIGN SPECIFICATIONS

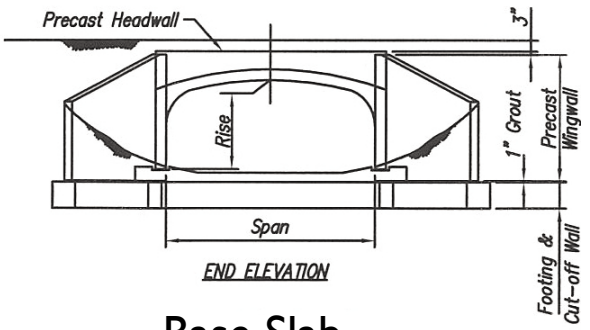
AASHTO:
Standard Specifications for Highway Bridges - Section 16.8
LRFD Bridge Design Specifications - Section 12.14

MANUFACTURING SPECIFICATIONS

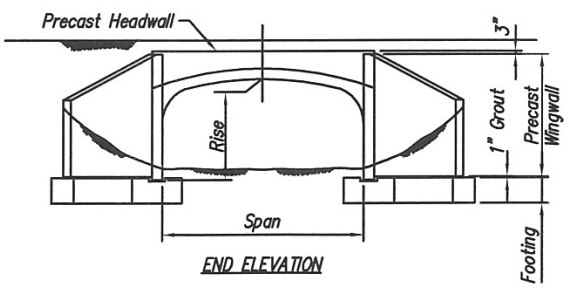
ASTM C1504

CONSPAN® BRIDGE SYSTEMS

BEBO® Arch Systems

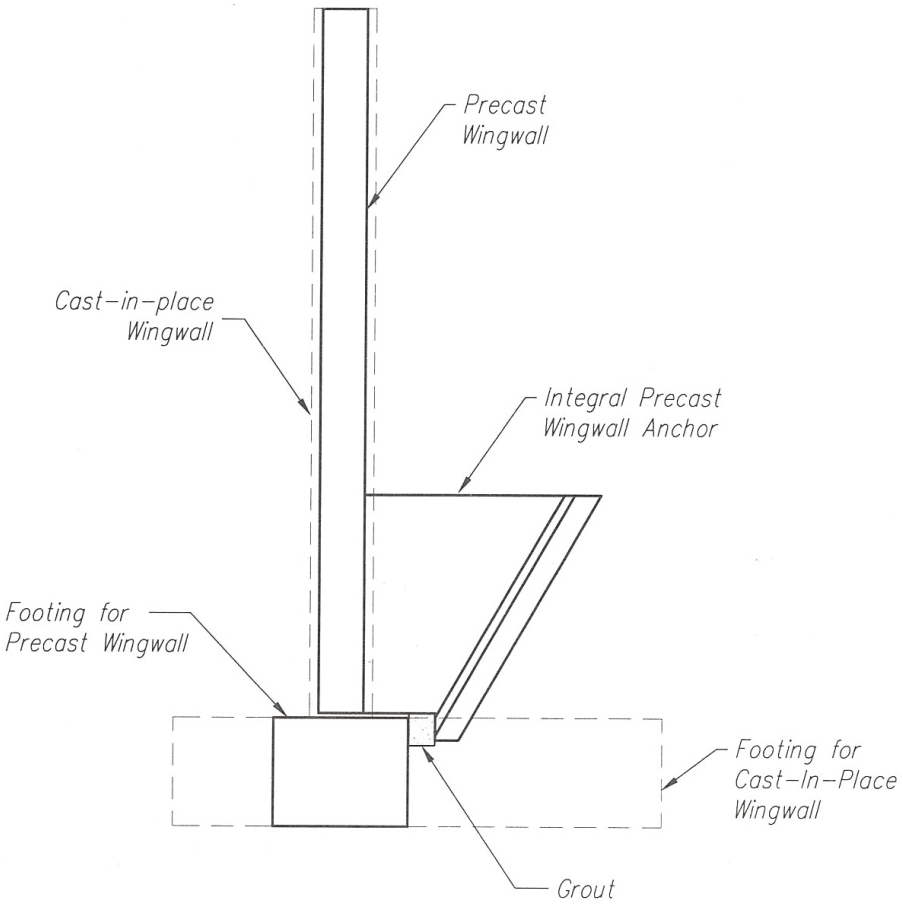


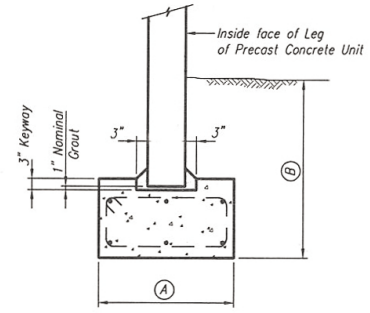
Base Slab



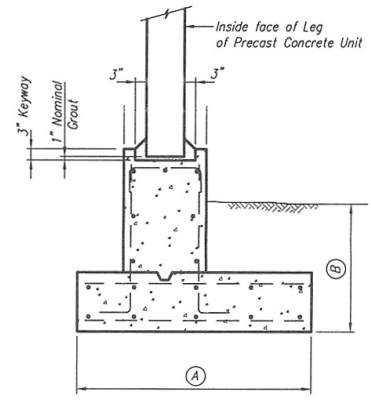
Strip Footing

Footing Details

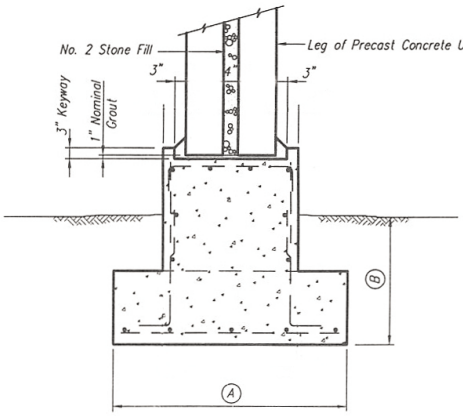




Strip Footing



Pedestal Wall Footing



Multi Cell Pier Footing

Significant Economic Advantages are Gained from Precast Wingwalls through:

- Narrower Footings
- Thinner Walls
- Reduced Excavation

BEBO® Arch Systems

E-Series Single Leaf

BEBO SERIES	SPAN (FEET)	RISE (FEET)	WATERWAY AREA (SF)	WEIGHT PER FOOT LENGTH (TONS)
E12	11'-2"	3'-6"	28	0.74
E12	11'-9 1/2"	4'-6"	40	0.84
E12	12'-0"	5'-6"	52	0.95
E12	12'-0"	6'-6"	64	1.06
E16	14'-4 1/2"	3'-10"	40	0.88
E16	15'-3 1/2"	4'-10"	54	1.00
E16	15'-10"	5'-10"	70	1.11
E16	16'-0"	6'-10"	86	1.21
E16	16'-0"	7'-10"	102	1.31
E20	18'-7"	5'-2"	70	1.16
E20	19'-4 1/2"	6'-2"	89	1.27
E20	19'-10"	7'-2"	108	1.37
E20	20'-0"	8'-2"	128	1.48
E20	20'-0"	9'-2"	148	1.58
E24	22'-9"	6'-6"	108	1.42
E24	23'-5 1/2"	7'-6"	132	1.53
E24	23'-10 1/2"	8'-6"	155	1.64
E24	24'-0"	9'-6"	179	1.74
E24	24'-0"	10'-6"	203	1.84
E24	24'-0"	11'-6"	227	1.94
E30	28'-11 1/2"	8'-6"	182	2.27
E30	29'-6 1/2"	9'-6"	211	2.43
E30	29'-11"	10'-6"	241	2.56
E30	30'-0"	11'-6"	271	2.69
E30	30'-0"	12'-6"	301	2.81
E30	30'-0"	13'-6"	331	2.94
E36	34'-8 1/2"	9'-2"	235	2.63
E36	35'-4 1/2"	10'-2"	270	2.78
E36	35'-9 1/2"	11'-2"	305	2.91
E36	36'-0"	12'-2"	341	3.05
E36	36'-0"	13'-2"	377	3.16
E42	40'-8 1/2"	10'-2"	307	3.05
E42	41'-4 1/2"	11'-2"	348	3.20
E42	41'-9 1/2"	12'-2"	389	3.33
E42	42'-0"	13'-2"	431	3.46
E48	47'-4"	12'-1"	431	3.96
E48	47'-9"	13'-1"	479	4.10

T-Series Single Leaf

BEBO SERIES	SPAN (FEET)	RISE (FEET)	WATERWAY AREA (SF)	WEIGHT PER FOOT LENGTH (TONS)
T22	22	2'-7 1/4"	39.1	1.49
T24	24	3'-2 1/4"	53.4	1.64
T26	26	3'-2 1/2"	56.1	1.58
T28	28	3'-9"	71.0	1.71
T30	30	4'-4 1/4"	88.6	1.84
T32	32	5'-0 1/4"	109.2	1.97
T34	34	4'-0 1/2"	92.0	2.27
T36	36	4'-6 1/2"	110.2	2.41
T38	38	5'-1"	130.8	2.55
T40	40	5'-8 1/4"	154.1	2.70
T42	42	6'-4"	180.4	2.85
T44	44	5'-4"	158.4	3.51
T46	46	5'-10 1/2"	182.3	3.68
T48	48	6'-5 1/4"	208.7	3.85
T50	50	7'-0"	237.8	4.03
T52	52	7'-8"	269.7	4.20
T54	54	6'-8"	242.9	4.29
T56	56	7'-3"	272.5	4.46
T58	58	7'-9"	304.6	4.64
T60	60	8'-4"	339.5	4.81
T62	62	9'-0"	377.2	4.99

ARCH LAY LENGTHS (Nominal)

E12 - E24:	8' LAY LENGTH
E30 - E66T:	6' LAY LENGTH
E72T - E84T:	4' LAY LENGTH
C30T - C54T:	6' LAY LENGTH
T22 - T24:	6' LAY LENGTH
T26 - T42:	8' LAY LENGTH
T44 - T52:	6' LAY LENGTH
T54 - T62:	4' LAY LENGTH
T64 - T82:	6' LAY LENGTH
T84 - T102:	4' LAY LENGTH

*1/2" Joints between Precast Concrete Units

C-Series Twin Leaf

BEBO SERIES	SPAN (FEET)	RISE (FEET)	WATERWAY AREA (SF)	WEIGHT PER FOOT LENGTH (TONS)
C30T	29'-4"	11'-4"	260	2.61
C30T	29'-9"	12'-4"	290	2.73
C30T	29'-11"	13'-4"	319	2.86
C30T	30'-0"	14'-4"	349	2.98
C30T	30'-0"	15'-4"	379	3.11
C30T	30'-0"	16'-4"	409	3.24
C30T	30'-0"	17'-4"	439	3.36
C30T	30'-0"	18'-4"	469	3.49
C36T	35'-6"	14'-4"	397	3.53
C36T	35'-9 1/2"	15'-4"	433	3.67
C36T	35'-11 1/2"	16'-4"	469	3.81
C36T	36'-0"	17'-4"	505	3.94
C36T	36'-0"	18'-4"	541	4.08
C36T	36'-0"	19'-4"	577	4.22
C36T	36'-0"	20'-4"	613	4.36
C36T	36'-0"	21'-4"	648	4.50
C36T	36'-0"	22'-4"	685	4.64
C36T	36'-0"	23'-4"	721	4.77
C42T	41'-7"	17'-0"	549	4.57
C42T	41'-10"	18'-0"	590	4.72
C42T	41'-11 1/2"	19'-0"	632	4.87
C42T	42'-0"	20'-0"	674	5.02
C42T	42'-0"	21'-0"	716	5.17
C42T	42'-0"	22'-0"	758	5.32
C42T	42'-0"	23'-0"	800	5.47
C42T	42'-0"	24'-0"	842	5.63
C42T	42'-0"	25'-0"	884	5.78
C42T	42'-0"	26'-0"	926	5.93
C54T	52'-7 1/2"	20'-4"	819	5.95
C54T	53'-0 1/2"	21'-4"	871	6.11
C54T	53'-5"	22'-4"	925	6.28
C54T	53'-8"	23'-4"	978	6.45
C54T	53'-10"	24'-4"	1032	6.62
C54T	53'-11 1/2"	25'-4"	1086	6.79
C54T	54'-0"	26'-4"	1140	6.96

E-Series Twin Leaf

BEBO SERIES	SPAN (FEET)	RISE (FEET)	WATERWAY AREA (SF)	WEIGHT PER FOOT LENGTH (TONS)
E54T	53'-7"	14'-0"	588	4.96
E54T	53'-11"	15'-0"	641	5.12
E54T	54'-0"	16'-0"	695	5.28
E54T	54'-0"	17'-0"	749	5.41
E54T	54'-0"	18'-0"	803	5.58
E54T	54'-0"	19'-0"	857	5.73
E54T	54'-0"	20'-0"	911	5.88
E60T	59'-11"	17'-0"	807	6.65
E60T	60'-0"	18'-0"	867	6.80
E60T	60'-0"	19'-0"	927	7.01
E60T	60'-0"	20'-0"	987	7.18
E60T	60'-0"	21'-0"	1047	7.36
E60T	60'-0"	22'-0"	1107	7.53
E66T	65'-11"	19'-0"	992	7.36
E66T	66'-0"	20'-0"	1058	7.54
E66T	66'-0"	21'-0"	1124	7.72
E66T	66'-0"	22'-0"	1190	7.89
E66T	66'-0"	23'-0"	1256	8.07
E66T	66'-0"	24'-0"	1322	8.24
E72T	71'-8 1/2"	19'-10"	1121	9.02
E72T	71'-11"	20'-10"	1192	9.23
E72T	72'-0"	21'-10"	1264	9.44
E72T	72'-0"	22'-10"	1336	9.64
E72T	72'-0"	23'-10"	1408	9.84
E72T	72'-0"	24'-10"	1480	10.04
E72T	72'-0"	25'-10"	1552	10.24
E78T	77'-9"	21'-10"	1137	9.84
E78T	77'-11"	22'-10"	1415	10.04
E78T	78'-0"	23'-10"	1493	10.25
E78T	78'-0	24'-10"	1571	10.45
E78T	78'-0	25'-10"	1649	10.65
E78T	78'-0	26'-10"	1727	10.85
E78T	78'-0	27'-10"	1805	11.05
E84T	83'-5 1/2"	22'-10"	1489	11.70
E84T	83'-9"	23'-10"	1572	11.94
E84T	83'-11"	24'-10"	1656	12.18
E84T	84'-0"	25'-10"	1740	12.41
E84T	84'-0"	26'-10"	1824	12.64
E84T	84'-0"	27'-10"	1908	12.86
E84T	84'-0"	28'-10"	1992	13.09
E84T	84'-0"	29'-10"	2076	13.31

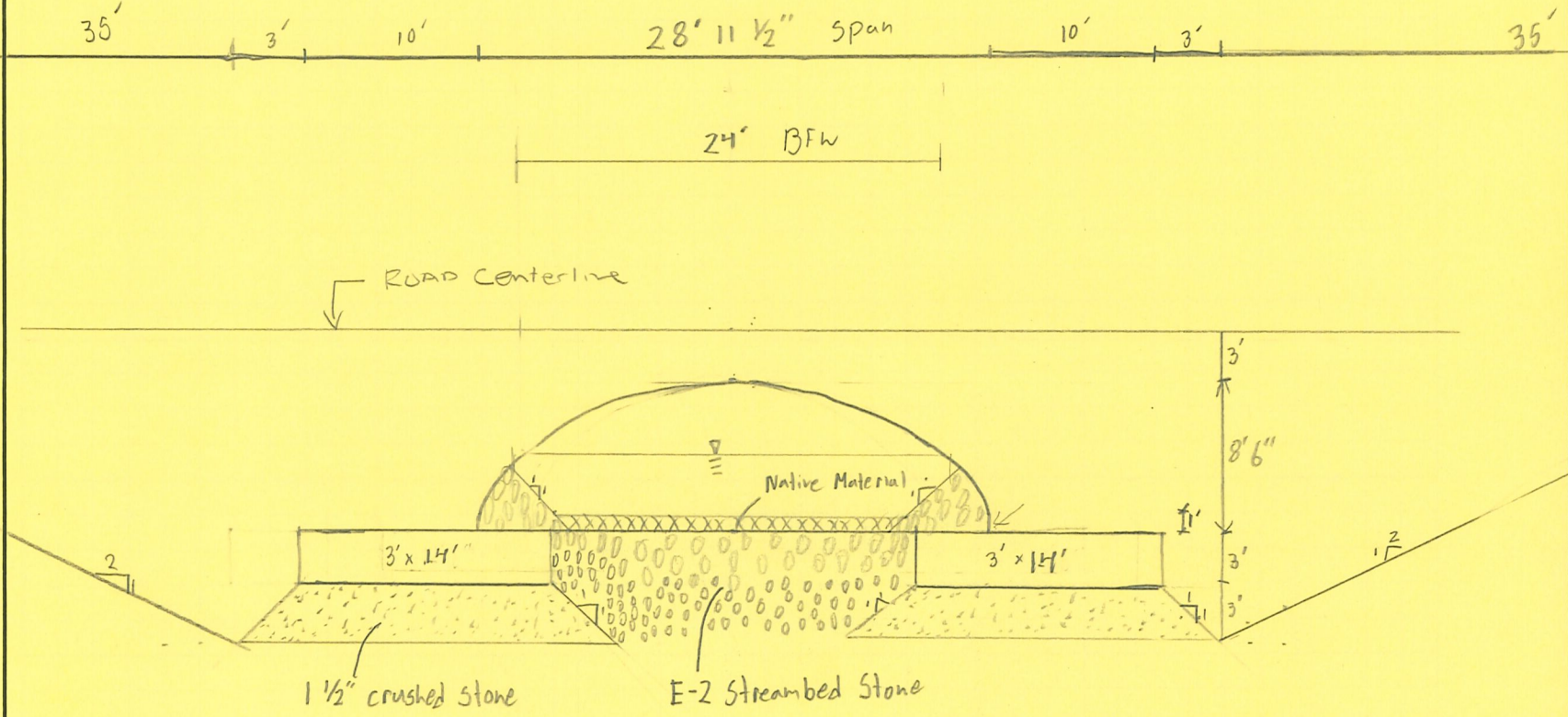
T-Series Twin Leaf

BEBO SERIES	SPAN (FEET)	RISE (FEET)	WATERWAY AREA (SF)	WEIGHT PER FOOT LENGTH (TONS)
T64T	64	7'-5"	340	5.51
T66T	66	7'-11"	375	5.70
T68T	68	8'-6"	413	5.88
T70T	70	9'-1"	454	6.07
T72T	72	9'-8"	497	6.26
T74T	74	8'-9"	460	6.86
T76T	76	9'-4"	504	7.06
T78T	78	9'-10"	545	7.26
T80T	80	10'-5"	592	7.47
T82T	82	11'-1"	641	7.67
T84T	84	10'-0"	599	8.82
T86T	86	10'-7"	646	9.04
T88T	88	11'-2"	695	9.27
T90T	90	11'-9"	747	9.50
T92T	92	12'-4"	802	9.74
T94T	94	11'-5"	755	11.04
T96T	96	11'-11"	808	11.30
T98T	98	12'-6"	863	11.56
T100T	100	13'-1"	921	11.82
T102T	102	13'-8"	982	12.08

job name: Tyler Bridge Road | job no: 859-006

date: | office: | by: NC | checked: | approved:

description: Single Leaf Arch Span: 28'-11½", Rise: 8'-6", Lay Length: 6'



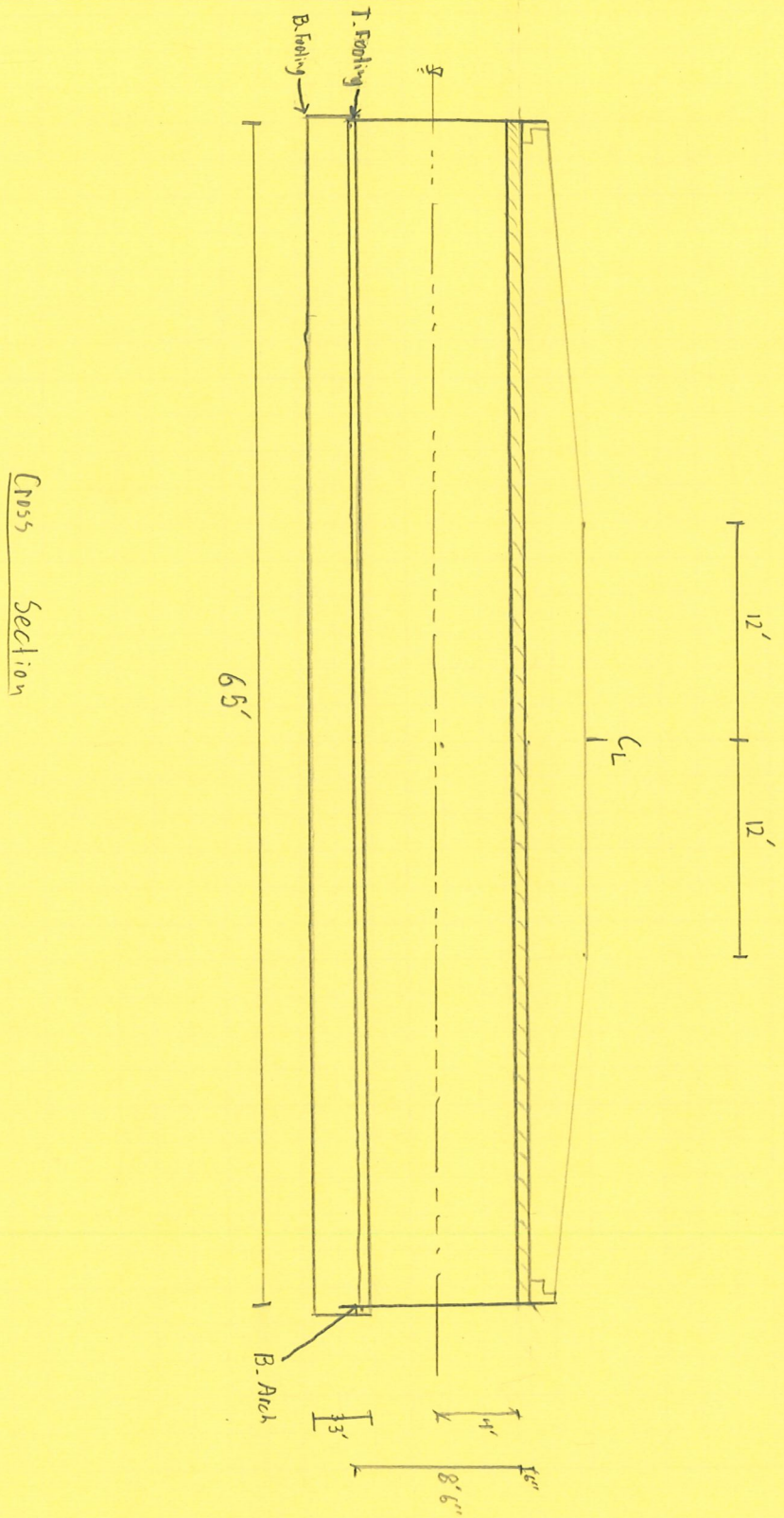
Cross Section

1" = 10'

1 of 3

OTTER CREEK ENGINEERING

job name: Tyler Bridge Road			job no: 859-006	
date:	office:	by: NC	checked:	approved:
description: BEBO E-Series Single Leaf Arch E-30 Span: 28'-11½", Rise: 8' 6", Lay Length: 6'				

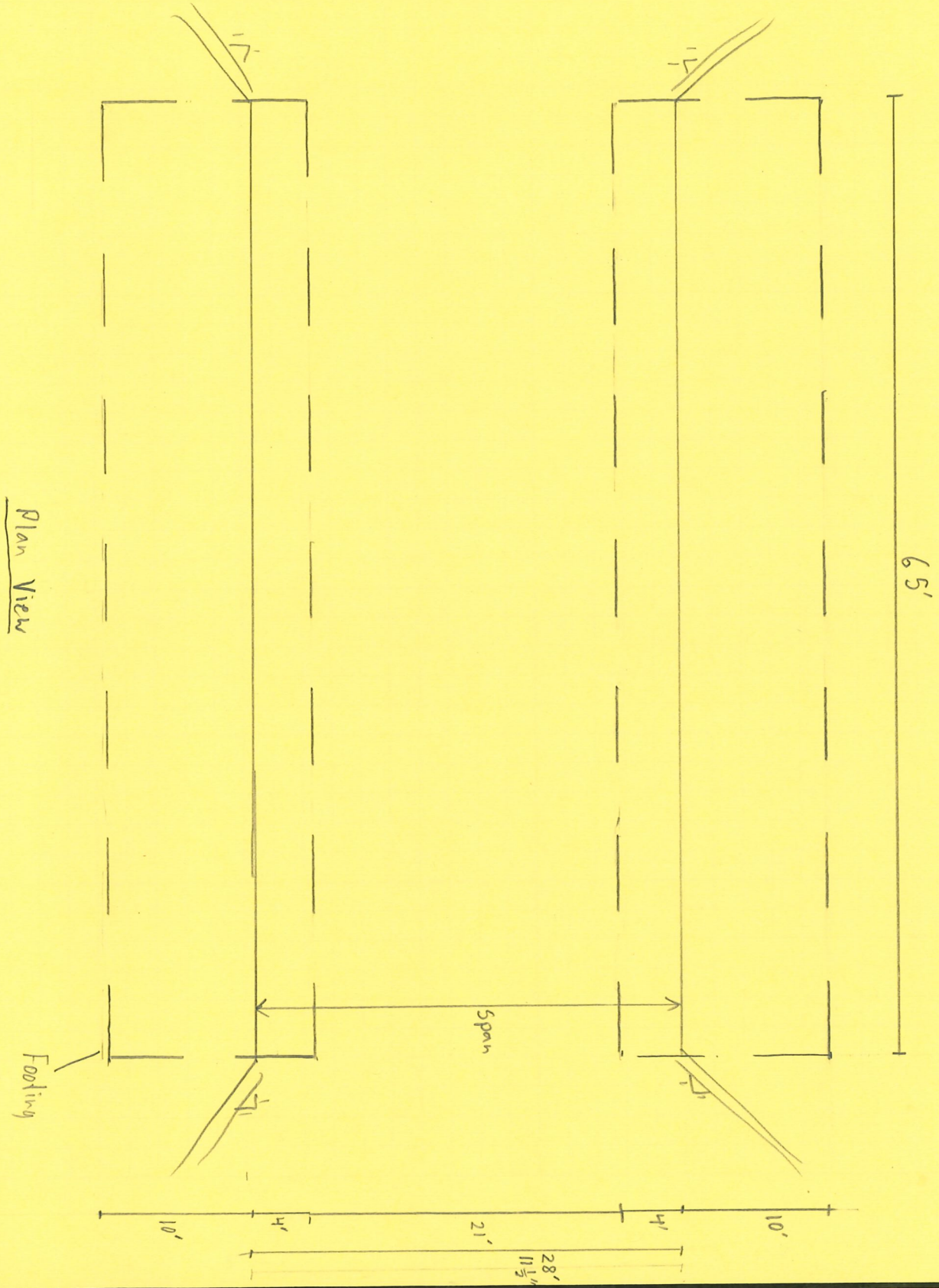


Cross Section

1:10

2 of 3

job name: Tyler Bridge Road			job no: 859-006	
date:	office:	by: NC	checked:	approved:
description: BEBO E-series Single Leaf Arch E-30 Span: 28'-11½", Rise: 8'-6", Lay Length: 6'				



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3 of 3

TOWN OF MONKTON, VERMONT

TYLER BRIDGE ROAD CULVERT REPLACEMENT - CONCRETE PLANKS / BRIDGE
ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
November 6, 2023

OTTER CREEK ENGINEERING

Item No.	Description	Unit	Est. Qty.	Cost/Unit	Total Cost
1.	**Contract General Conditions**				
	General Conditions (Bonds Insurance)	L.S.	1	$50,000.00	$50,000
	Erosion Control/ Silt Fencing/Maintenance	L.S.	1	$6,000.00	$6,000
	Traffic Control / Signs, Barracades, etc.	L.S.	1	$4,000.00	$4,000
	Mobilization and Demobilization	L.S.	1	$35,000.00	$35,000
			Contract General Conditions Subtotal =		**$95,000**
2.	**Culvert Replacement**				
	Excavation, haul unsuitable offsite	C.Y.	1,550	$ 45.00	$69,750
	Bypass pump, divert flows	WK	4	$ 2,500.00	$10,000
	Disassemble and remove existing culvert	Hr.	6	$ 350.00	$2,100
	H-Piles	LF	600	$80	$48,000
	Cast in place concrete footings w/reinforcing	C.Y.	80	$400	$32,000
	Crane	LS	1	$ 10,800.00	$10,800
	325, Labor install planksculvert	LS	1	$ 15,000.00	$15,000
	Precast Concrete Planks	EA.	1	$ 120,000.00	$120,000
	Field Grouting	LS	1	$ 5,000.00	$5,000
	Water Proofing	LS	1	$ 5,000.00	$5,000
	Filter fabric	RL	3	$ 1,000.00	$3,000
	Precast Concrete Block - 2'x2'x4'	EA.	30	$300	$9,000
	Streambed Stone Type E2 Against Footings and Interior Walls	C.Y.	150	$ 70.00	$10,500
	Native Backfill Material (inside culvert)	C.Y.	60	$ 40.00	$2,400
	ENVELOPE	C.Y.	95	$ 50.00	$4,741
	Embankment material	C.Y.	720	$ 45.00	$32,400
	Dense Graded Crushed Stone (Road Base)	C.Y.	170	$ 55.00	$9,350
	Surface Crushed Gravel (Road Base)	C.Y.	60	$ 55.00	$3,300
	Bituminous Paving (base and top)	Ton	55	$ 300.00	$16,500
	Guardrail	L.F.	100	$ 65.00	$6,500
	Restoration of Surfaces	S.F.	4000	$ 2.50	$10,000
			Culvert Replacement Subtotal =		**$425,000**
3	**Earthwork**				
	Rock Excavation	C.Y.	20	$ 250.00	$5,000
	Additional Excavation Below Subgrade	C.Y.	25	$ 45.00	$1,125
	Additional Rip-rap	C.Y.	25	$ 70.00	$1,750
	Additional 1 1/2-inch Crushed Stone Bedding	C.Y.	35	$ 50.00	$1,750
	Miscellaneous Excavation and Backfill	C.Y.	20	$ 70.00	$1,400
			Earthwork Subtotal =		**$11,000**
				Subtotal =	**$531,000**
				+ Contingency (15%) =	$80,000
			TOTAL OPINION OF PROBABLE CONSTRUCTION COST =		**$611,000**

Notes:

1- This estimate has been prepared for the Town's use in project budget planning.
2- Subtotal amounts have been rounded to the nearest $1,000.
3- Overall anticipated project cost has been rounded to the nearest $1,000.
4- Anticipated costs have been developed without a formal survey or final design and are based on a site visit and field measurements by Otter Creek Engineering, Inc.
5- In situ soil conditions have not been evaluated. Foundations based on presumed dimensions of similar sized structures and soil conditions.
6- Unit pricing is based on similar recent projects and discussions with suppliers/manufacturers.
7- Legal, engineering, and permitting costs have not been included.

CON/SPAN® BRIDGE SYSTEMS

STANDARD CON/SPAN® BRIDGE UNITS																							
WATERWAY AREA (FT.^{2})													WEIGHT (TONS/FT.)										
RISE (FT.)	SPAN (FEET)												SPAN (FEET)										
	12	14	16	20	24	28	32	36	42	48	54	60	12	14	16	20	24	28	32	36	42	48	54	60
3	30	*	*	*	*	*	*	*	*	*	*	*	.94	*	*	*	*	*	*	*	*	*	*	*
4	42	50	55	65	*	*	*	*	*	*	*	*	1.04	1.14	1.59	1.73	*	*	*	*	*	*	*	*
5	54	64	71	85	95	*	*	*	*	*	*	*	1.14	1.24	1.71	1.86	2.05	*	*	*	*	*	*	*
6	66	78	87	105	119	139	*	*	*	*	*	*	1.24	1.34	1.83	1.99	2.18	2.84	*	*	*	*	*	*
7	78	92	103	125	143	167	184	*	*	*	*	*	1.34	1.44	1.96	2.12	2.31	2.99	3.56	*	*	*	*	*
8	90	106	119	145	167	195	216	232	*	*	*	*	1.44	1.54	2.09	2.24	2.44	3.14	3.71	4.06	*	*	*	*
9	102	120	135	165	191	223	248	268	*	*	*	*	1.54	1.64	2.21	2.36	2.57	3.29	3.86	4.23	*	*	*	*
10	114	134	151	185	215	251	280	304	334	387	435	*	1.64	1.74	2.33	2.49	2.69	3.44	4.01	4.40	4.87	5.27	6.52	*
11	*	*	*	*	239	279	312	340	376	435	489	*	*	*	*	*	2.81	3.59	4.16	4.58	5.04	5.48	6.72	*
12	*	*	*	*	*	*	344	376	418	483	543	578	*	*	*	*	*	*	4.31	4.76	5.21	5.67	6.92	7.76
13	*	*	*	*	*	*	*	412	460	531	599	638	*	*	*	*	*	*	*	4.93	5.38	5.88	7.12	7.98
14	*	*	*	*	*	*	*	448	501	579	652	698	*	*	*	*	*	*	*	5.11	5.58	6.08	7.32	8.21

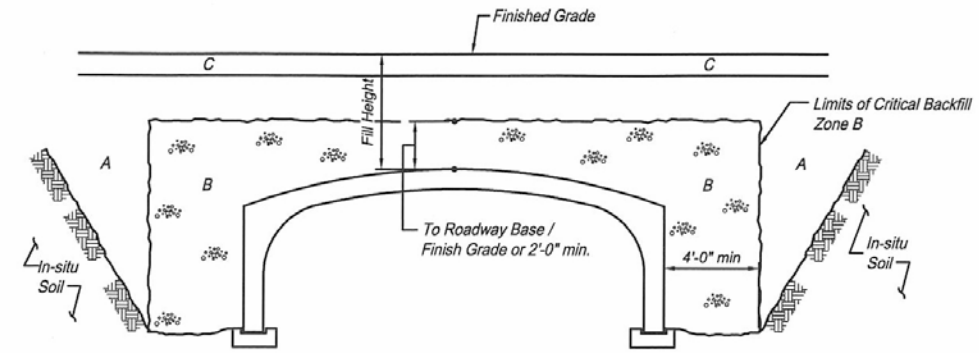
ARCH LAY LENGTHS (Nominal)

12'-24' SPAN	8' LAY LENGTH
28'-42' SPAN	6' LAY LENGTH
48'-60' SPAN	4' LAY LENGTH

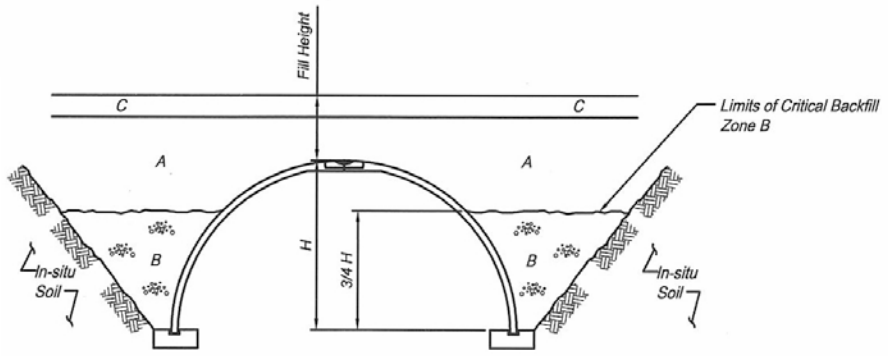
*1/4" Joints between Precast Concrete Units

Backfill Requirements

Backfill is a key component of any buried structure.
Please refer to the precast element specifications for detailed requirements.



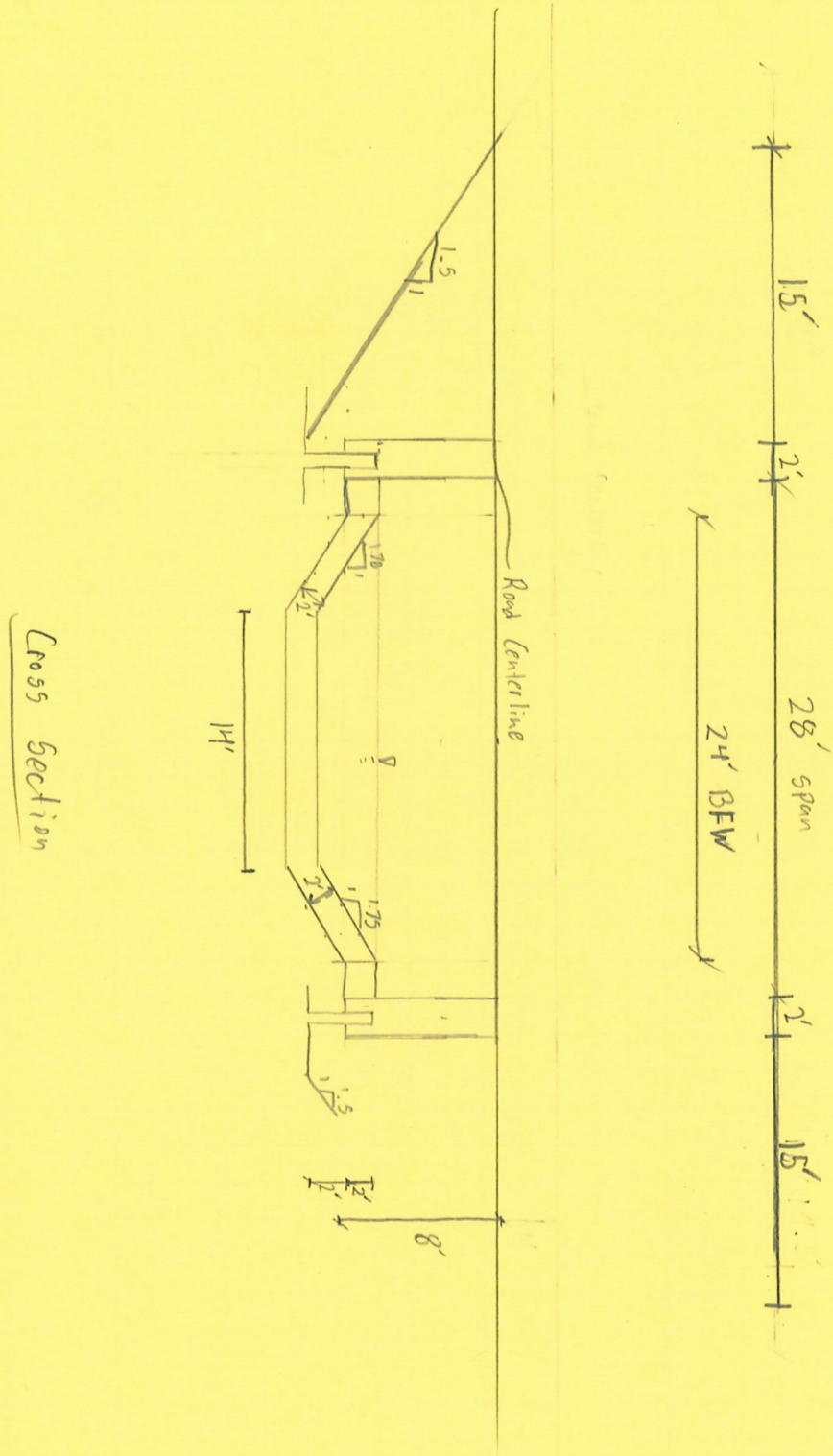
CON/SPAN® Arch



BEBO® Arch

1. In-situ material must be sufficiently stable to allow support of the precast units.
2. Zone A: Embankment or overfill material shall be properly graded and compacted, per project specifications.
3. Zone B: Structural backfill material per CON/SPAN® or BEBO® specifications. (Generally, a well-graded angular sand or gravel placed in 8" lifts and compacted to 95% of the maximum dry density, per AASHTO T-99 specification.)
4. Zone C: Roadway base and surface materials, per project specifications.

job name: Tyler Bridge Rd			job no: 859-006	
date:	office:	by: NC	checked:	approved:
description: Plank Bridge		Span: 28', Rise: 8', Lay Length: 6'		



Cross Section

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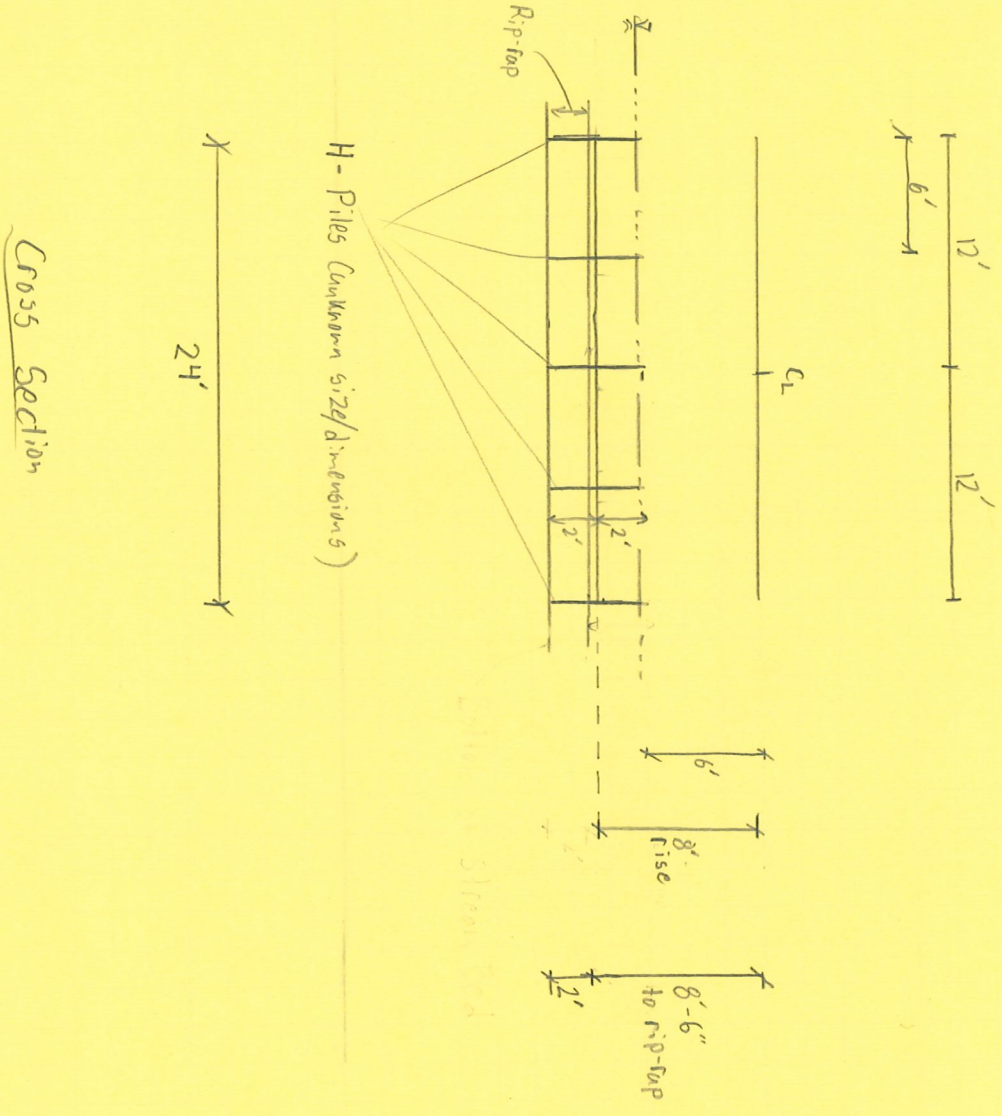
1 of 3

job name: Tyler Bridge Rd			job no: 854-006	
date:	office:	by:	checked:	approved:
description: Plank Bridge Span: 26', Rise: 8', Lay Length: 6'				



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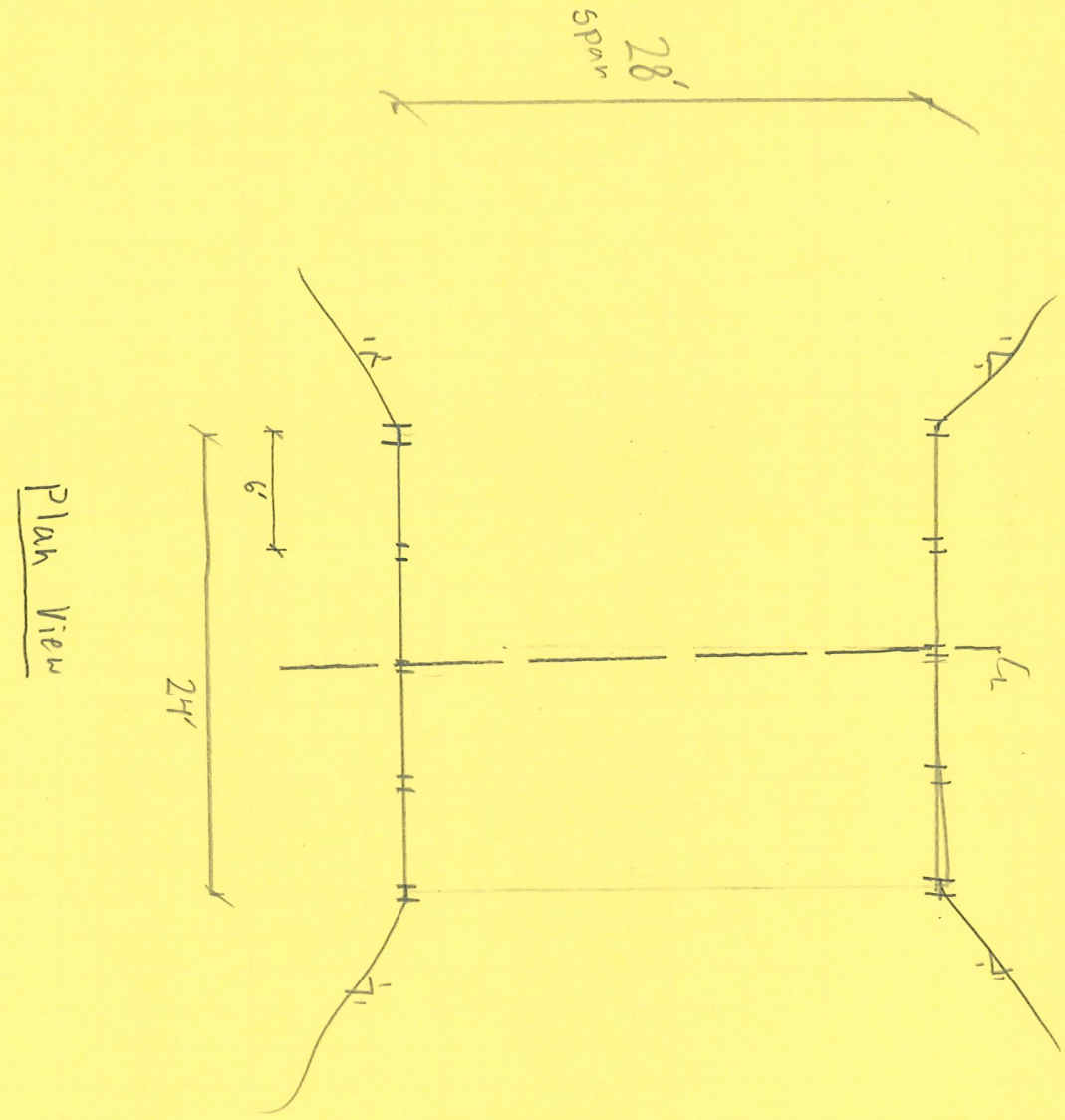
2 of 3

job name: Tyler Bridge Rd			job no: 859-006	
date:	office:	by: NL	checked:	approved:
description: Plank Bridge		Span: 28', Rise: 8', Lay Length: 6'		



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3 of 3

TOWN OF MONKTON, VERMONT

TYLER BRIDGE ROAD CULVERT REPLACEMENT - METAL ARCH CULVERT

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

November 7, 2023

OTTER CREEK ENGINEERING

Item No.	Description	Unit	Est. Qty.	Cost/Unit	Total Cost
1.	**Contract General Conditions**				
	General Conditions (Bonds Insurance)	L.S.	1	$50,000.00	$50,000
	Erosion Control/ Silt Fencing/Maintenance	L.S.	1	$6,000.00	$6,000
	Traffic Control / Signs, Barracades, etc.	L.S.	1	$4,000.00	$4,000
	Mobilization and Demobilization	L.S.	1	$ 35,000.00	$35,000
			Contract General Conditions Subtotal =		**$95,000**
2.	**Culvert Replacement**				
	Excavation, haul unsuitable offsite	C.Y.	1,550	$ 45.00	$69,750
	Bypass pump, divert flows	WK	4	$ 2,500.00	$10,000
	Disassemble and remove existing culvert	Hr.	6	$ 350.00	$2,100
	1 1/2-inch crushed stone bedding	C.Y.	150	$ 50.00	$7,500
	Steel Express Foundations	EA.	1	$77,000	$77,000
	Crane	LS	1	$ 24,000.00	$24,000
	325, Labor install arch culvert	LS	1	$ 20,000.00	$20,000
	Metal Arch Culvert, and wing walls	EA.	1	$ 214,500.00	$214,500
	Streambed Stone Type E2 Against Footings and Interior Walls	C.Y.	150	$ 70.00	$10,500
	Native Backfill Material (inside culvert)	C.Y.	60	$ 40.00	$2,400
	Water Proofing	LS	1	$ 8,000.00	$8,000
	ENVELOPE	C.Y.	320	$ 35.00	$11,200
	Filter fabric	RL	3	$ 1,000.00	$3,000
	Embankment material	C.Y.	1,000	$ 45.00	$45,000
	Dense Graded Crushed Stone (Road Base)	C.Y.	170	$ 55.00	$9,350
	Surface Crushed Gravel (Road Base)	C.Y.	60	$ 55.00	$3,300
	Bituminous Paving (base and top)	Ton	55	$ 300.00	$16,500
	Guardrail	L.F.	100	$65	$6,500
	Restoration of Surfaces	S.F.	4,000	$ 2.50	$10,000
			Culvert Replacement Subtotal =		**$551,000**
3	**Earthwork**				
	Rock Excavation	C.Y.	20	$ 250.00	$5,000
	Additional Excavation Below Subgrade	C.Y.	25	$ 45.00	$1,125
	Additional Rip-rap	C.Y.	25	$ 70.00	$1,750
	Additional 1 1/2-inch Crushed Stone Bedding	C.Y.	35	$ 50.00	$1,750
	Miscellaneous Excavation and Backfill	C.Y.	20	$ 70.00	$1,400
			Earthwork Subtotal =		**$11,000**
				Subtotal =	**$657,000**
				+ Contingency (15%) =	$99,000
			TOTAL OPINION OF PROBABLE CONSTRUCTION COST =		**$756,000**

Notes:

1- This estimate has been prepared for the Town's use in project budget planning.
2- Subtotal amounts have been rounded to the nearest $1,000.
3- Overall anticipated project cost has been rounded to the nearest $1,000.
4- Anticipated costs have been developed without a formal survey or final design and are based on a site visit and field measurements by Otter Creek Engineering, Inc.
5- In situ soil conditions have not been evaluated. Foundations based on presumed dimensions of similar sized structures and soil conditions.
6- Unit pricing is based on similar recent projects and discussions with suppliers/manufacturers.
7- Legal, engineering, and permitting costs have not been included.

I - GENERAL

1.0 STANDARDS AND DEFINITIONS

1.1 STANDARDS - ALL STANDARDS REFER TO LATEST EDITION UNLESS OTHERWISE NOTED.

1.1.1 ASTM B-864 "STANDARD SPECIFICATION FOR CORRUGATED ALUMINUM BOX CULVERTS" (AASHTO DESIGNATION M-219).

1.1.2 AASHTO STANDARD SPECIFICATION FOR HIGHWAY BRIDGES - SECTION 12 DIVISION I - DESIGN.

1.1.3 AASHTO STANDARD SPECIFICATION FOR HIGHWAY BRIDGES - SECTION 26DIVISION II - CONSTRUCTION.

1.2 DEFINITIONS

1.2.1 OWNER - IN THESE SPECIFICATIONS THE WORD "OWNER" SHALL MEAN CONTECH Engineered Solutions, LLC.

1.2.2 ENGINEER - IN THESE SPECIFICATIONS THE WORD "ENGINEER" SHALL MEAN THE ENGINEER OF RECORD OR OWNER'S DESIGNATED ENGINEERING REPRESENTATIVE.

1.2.3 MANUFACTURER - IN THESE SPECIFICATIONS THE WORD "MANUFACTURER" SHALL MEAN CONTECH ENGINEERED SOLUTIONS, LLC 800-338-1122 Winchester.

1.2.4 CONTRACTOR - IN THESE SPECIFICATIONS THE WORD "CONTRACTOR" SHALL MEAN THE FIRM OR CORPORATION UNDERTAKING THE EXECUTION OF ANY INSTALLATION WORK UNDER THE TERMS OF THESE SPECIFICATIONS.

1.2.5 APPROVED - IN THESE SPECIFICATIONS THE WORD "APPROVED" SHALL REFER TO THE APPROVAL OF THE ENGINEER OR HIS DESIGNATED REPRESENTATIVE.

1.2.6 AS DIRECTED - IN THESE SPECIFICATIONS THE WORDS "AS DIRECTED" SHALL REFER TO THE DIRECTIONS TO THE CONTRACTOR FROM THE OWNER OR HIS DESIGNATED REPRESENTATIVE.

2.0 GENERAL CONDITIONS

2.1 THE CONTRACTOR SHALL FURNISH ALL LABOR, MATERIAL AND EQUIPMENT AND PERFORM ALL WORK AND SERVICES EXCEPT THOSE SET OUT AND FURNISHED BY THE OWNER, NECESSARY TO COMPLETE IN A SATISFACTORY MANNER THE SITE PREPARATION, EXCAVATION, FILLING, COMPACTION, GRADING AS SHOWN ON THE PLANS AND AS DESCRIBED THEREIN. THIS WORK SHALL CONSIST OF ALL MOBILIZATION CLEARING AND GRADING, GRUBBING, STRIPPING, REMOVAL OF EXISTING MATERIAL UNLESS OTHERWISE STATED, PREPARATION OF THE LAND TO BE FILLED, FILLING OF THE LAND, SPREADING AND COMPACTION OF THE FILL, AND ALL SUBSIDIARY WORK NECESSARY TO COMPLETE THE GRADING OF THE CUT AND FILL AREAS TO CONFORM WITH THE LINES, GRADES, SLOPES, AND SPECIFICATIONS. THIS WORK IS TO BE ACCOMPLISHED UNDER THE OBSERVATION OF THE OWNER OR HIS DESIGNATED REPRESENTATIVE.

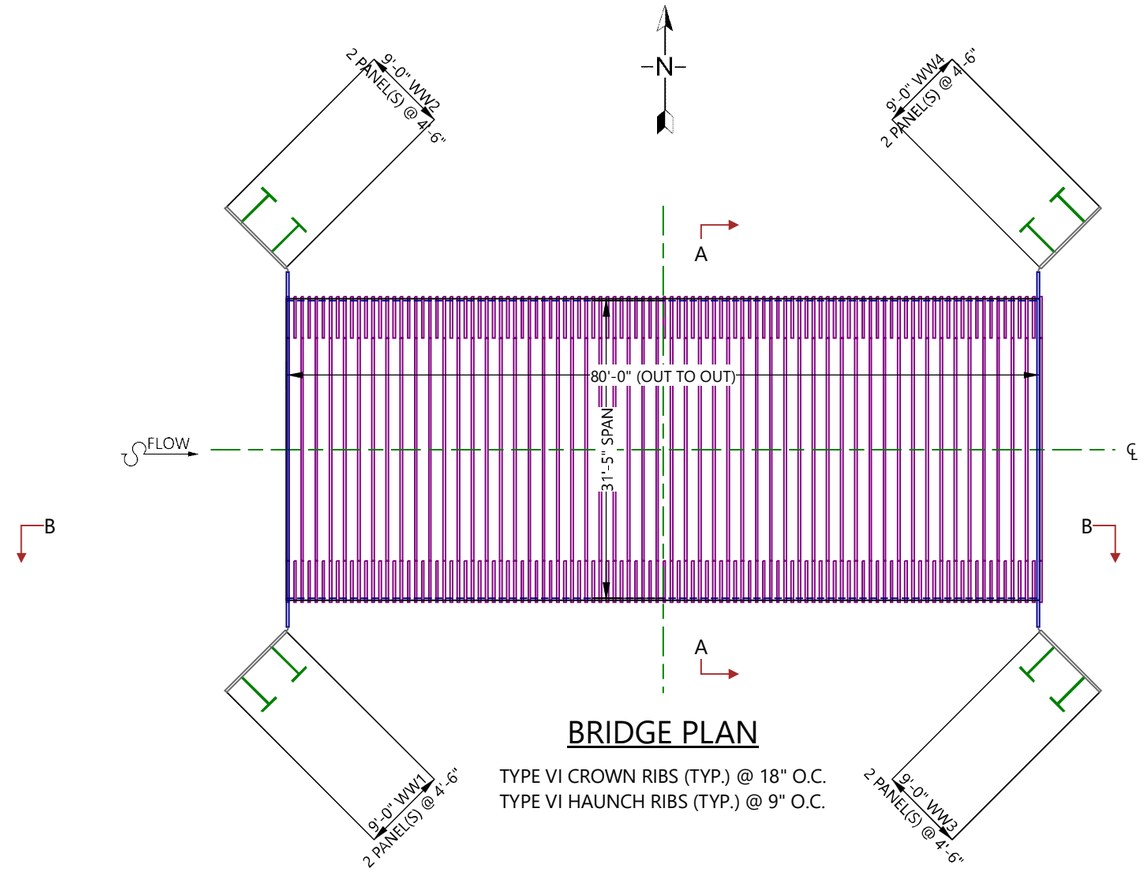
2.2 PRIOR TO BIDDING THE WORK, THE CONTRACTOR SHALL EXAMINE, INVESTIGATE AND INSPECT THE CONSTRUCTION SITE AS TO THE NATURE AND LOCATION OF THE WORK, AND THE GENERAL AND LOCAL CONDITIONS AT THE CONSTRUCTION SITE, INCLUDING WITHOUT LIMITATION, THE CHARACTER OF SURFACE OR SUBSURFACE CONDITIONS AND OBSTACLES TO BE ENCOUNTERED ON AND AROUND THE CONSTRUCTION SITE AND SHALL MAKE SUCH ADDITIONAL INVESTIGATION AS HE MAY DEEM NECESSARY FOR THE PLANNING AND PROPER EXECUTION OF THE WORK.

IF CONDITIONS OTHER THAN THOSE INDICATED ARE DISCOVERED BY THE CONTRACTOR, THE OWNER SHALL BE NOTIFIED IMMEDIATELY. THE MATERIAL WHICH THE CONTRACTOR BELIEVES TO BE A CHANGED CONDITION SHALL NOT BE DISTURBED SO THAT THE OWNER CAN INVESTIGATE THE CONDITION.

2.3 THE CONSTRUCTION SHALL BE PERFORMED UNDER THE DIRECTION OF THE ENGINEER.

2.4 ALL ASPECTS OF THE STRUCTURE DESIGN AND SITE LAYOUT INCLUDING FOUNDATIONS, BACKFILL, END TREATMENTS AND NECESSARY SCOUR CONSIDERATION SHALL BE PERFORMED BY THE ENGINEER.

ANY INSTALLATION GUIDANCE PROVIDED HEREIN SHALL BE ENDORSED BY THE ENGINEER OR SUPERSEDED BY THE ENGINEER'S PLANS AND SPECIFICATIONS.



BRIDGE PLAN

TYPE VI CROWN RIBS (TYP.) @ 18" O.C.
TYPE VI HAUNCH RIBS (TYP.) @ 9" O.C.

PRELIMINARY
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MARK	DATE	REVISION DESCRIPTION	BY

CONTECH® ENGINEERED SOLUTIONS
9025 Centre Pointe Dr., Suite 400, West Chester, OH 4506
800-338-1122 513-645-7000 513-645-7993 FAX

PROPOSAL
DRAWING

CULVERT REPLACEMENT - MONKTON VT

NORTH FERRISBURGH, VT

Project No.:	Seq No.:	Date:
777264	010	10/27/2023
Designed: GR	Drawn:	
Checked:	Approved:	
Sheet No.: 1 OF 7		

II - ALUMINUM BOX CULVERT

1.0 GENERAL

1.1 Manufacturer shall fabricate the aluminum box culvert as shown on the plans. Fabrication shall conform to the requirements of ASTM B-864 and shall consist of plates, ribs, and appurtenant items.

Plate thickness, rib spacing, end treatment and type of invert and foundation shall be as indicated on the plans. All manufacturing processes including corrugating, punching, curving and required galvanizing shall be performed within the United States of America.

1.2 The contractor shall verify all field dimensions and conditions prior to ordering materials.

2.0 DIMENSIONS

Designation: ALBC 116-L1
Span: 31'-5"
Rise: 7'-3"
Min. Cover: 2'-0"
Max. Cover: 3'-0"
Loading: HL-93

2.1 The proposed structure shall be an ALUMINUM BOX CULVERT with the following dimensions:

2.2 All plan dimensions on the contract drawings are measured in a true horizontal plan unless otherwise noted.

3.0 ASSEMBLY AND INSTALLATION

3.1 Bolts and nuts shall conform to the requirements of ASTM A-307 or ASTM A-449. The box culvert shall be assembled in accordance with the plate layout drawings provided by the manufacturer and per the manufacturer's recommendations.

Bolts shall be tightened using an applied torque of between 100 and 150 ft.-lbs.

3.2 The box culvert shall be installed in accordance with the plans and specifications, the manufacturer's recommendations, and AASHTO Standard Specification for Highway Bridges - Section 26 Division II - Construction.

3.3 Trench excavation shall be made in embankment material that is structurally adequate. The trench width shall be shown on the plans. Poor quality in situ embankment material must be removed and replaced with suitable backfill as directed by the Engineer.

3.4 Bedding preparation is critical to both structure performance and service life. The bed should be constructed to uniform line and grade to avoid distortions that may create undesirable stresses in the structure and/or rapid deterioration of the roadway. The bed should be free of rock formations, protruding stones, frozen lumps, roots, and other foreign matter that may cause unequal settlement.

3.5 Bedding shall provide a minimum of 4,000 psf bearing capacity. Foundation details for bearing capacity less than 4,000 psf shall be approved by the Engineer.

3.6 The structure shall be assembled in accordance with the Manufacturer's instructions. All plates shall be unloading and handled with reasonable care. Plates shall not be rolled or dragged over gravel rock and shall be prevented from striking rock or other hard objects during placement in trench or on bedding.

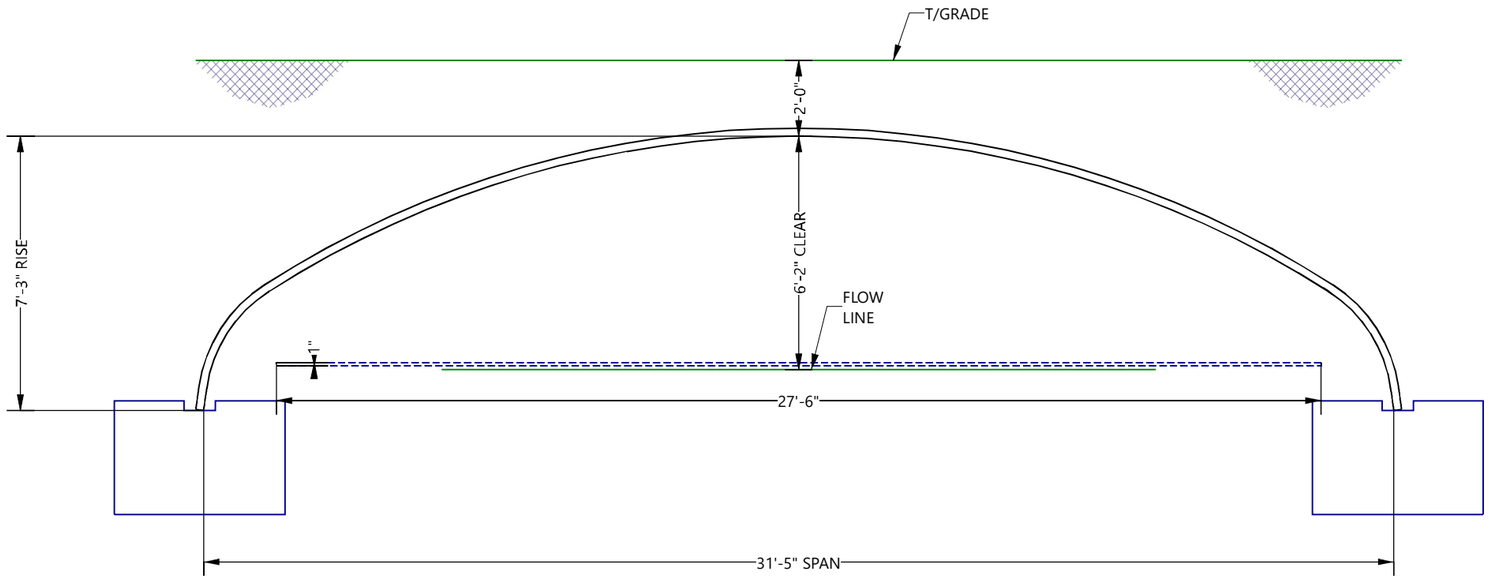
When installed on a full invert or on flexible footing pads, assembly of the invert or footing pads shall start at the downstream end. Circumferential seam laps shall shingle over the top of the downstream plates as assembly progresses upstream. Whether the box culvert is installed on a concrete footing, full metal invert, or flexible footing pad, assembly of the structure shell shall start at the upstream end. Downstream rings of plates shall be assembled outside of the upstream rings. (Circumferential seams are shingled downstream when viewed from the inside of the shell).

3.7 The structure shall be backfilled using clean well graded granular material that meets the requirements for soil classifications A-1, A-2-4, A-2-5 or A-3 modified to be more select than AASHTO M-145. See the information at the right of this sheet.

Backfill must be placed symmetrically on each side of the structure in 6 to 8 inch loose lifts. Each lift shall be compacted to a minimum of 90 percent density per AASHTO T-180

3.8 Construction loads that exceed highway load limits are not allowed to cross the structure without approval from the Engineer.

Normal highway traffic is not allowed to cross the structure until the structure has been backfilled and paved. If the road is unpaved, cover allowance to accommodate rutting shall be as directed by the Engineer.



CROSS SECTION A-A

Approximate Area: 140 sq. ft. used, 173 sq. ft. total

NOTES

- MEASUREMENTS ARE TO THE INSIDE CRESTS OF THE CORRUGATION
- DIMENSIONS ARE SUBJECT TO MANUFACTURING TOLERANCES

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PROPOSAL
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NORTH FERRISBURGH, VT

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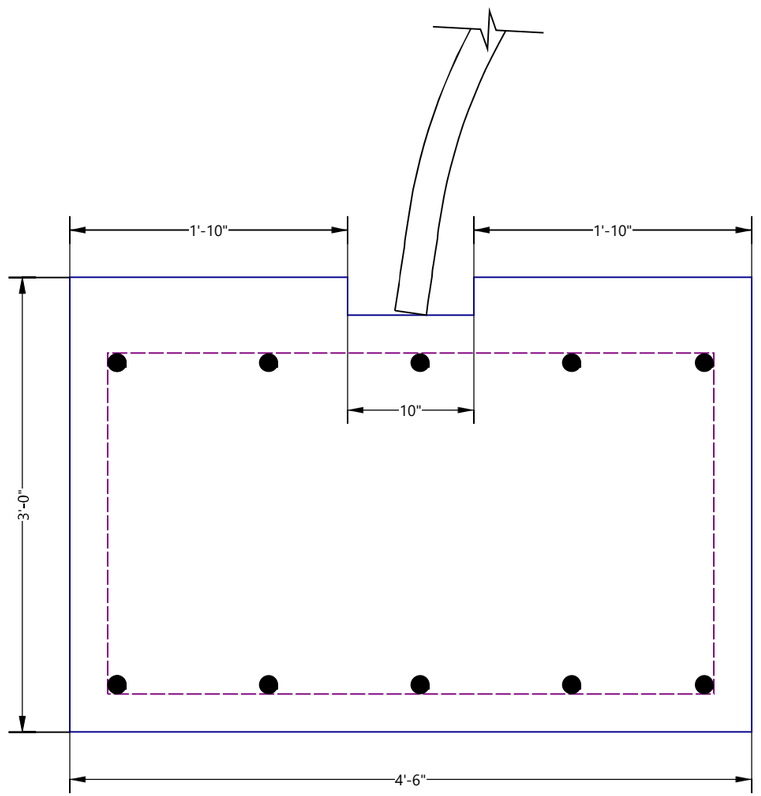

TYPICAL FOOTING DETAIL

NOTES
- FOOTING DIMENSIONS AND DETAILS SHOWN ARE CONCEPTUAL ONLY
- FINAL DIMENSIONS & DETAILS TO BE FURNISHED BY THE PROJECT ENGINEERS
- FOUNDATION REINFORCING TO BE DETERMINED

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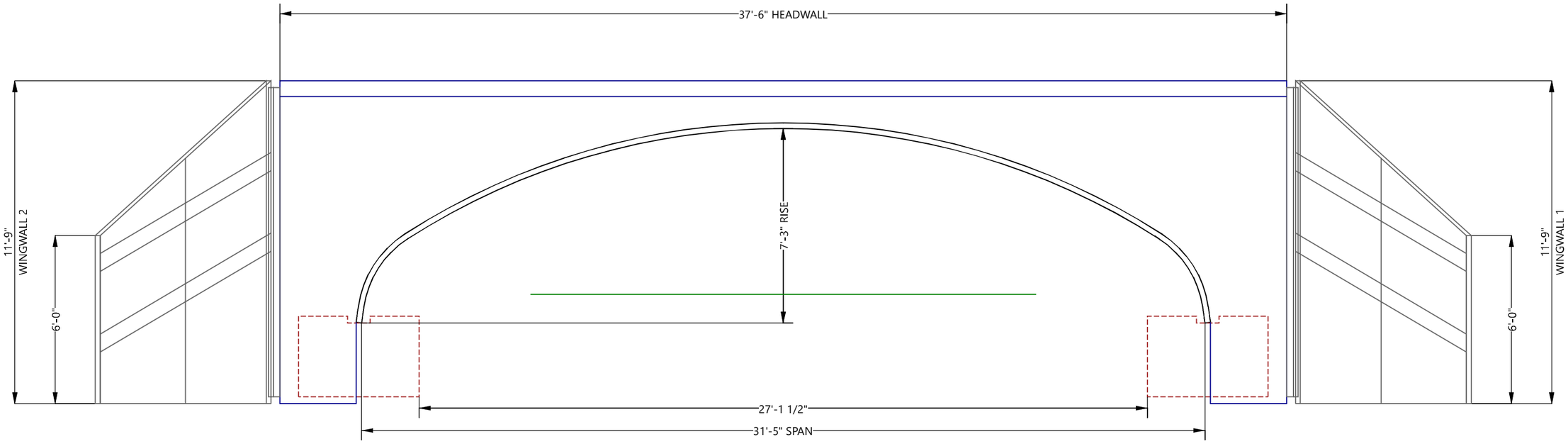

TYPICAL END ELEVATION

ALUMINUM HEADWALL TO BE FIELD CUT AT TIME OF INSTALLATION (BY OTHERS)

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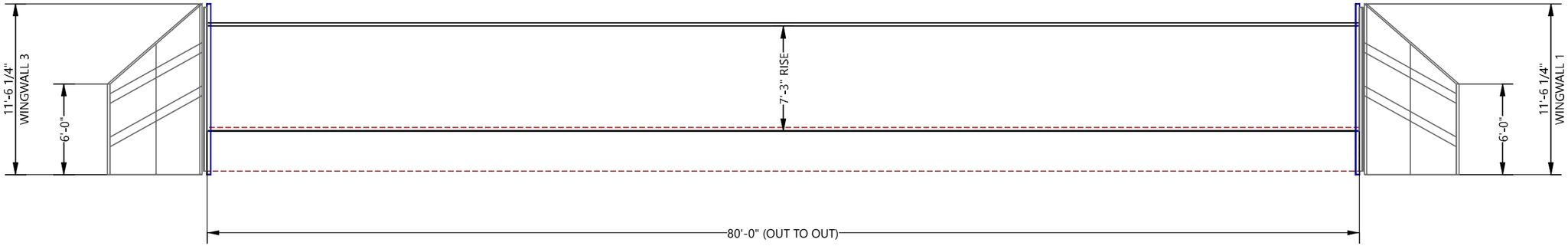

PROFILE SECTION B-B

PRELIMINARY
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PROPOSAL
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CULVERT REPLACEMENT - MONKTON VT

NORTH FERRISBURGH, VT

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Sheet No.: 5 OF 7		

SPECIFICATIONS FOR MANUFACTURE AND INSTALLATION OF CONTECH® ALUMINUM BOX CULVERT #1-87

I - GENERAL

1.0 STANDARDS AND DEFINITIONS

1.1 STANDARDS - All standards refer to latest edition unless otherwise noted.

1.1.1 ASTM B-864 "Standard Specification for Corrugated Aluminum Box Culverts" (AASHTO Designation M-219).

1.1.2 AASHTO Standard Specification for Highway Bridges - Section 12 Division I - Design.

1.1.3 AASHTO Standard Specification for Highway Bridges - Section 26 Division II - Construction.

1.2 DEFINITIONS

1.2.1 Owner - In these specifications the word "Owner" shall mean Town of Monkton

1.2.2 Engineer - In these specifications the word "Engineer" shall mean the Engineer of Record or Owner's designated engineering representative.

1.2.3 Manufacturer - In these specifications the word "Manufacturer" shall mean CONTECH ENGINEERED SOLUTIONS 800-338-1122 GR

1.2.4 Contractor - In these specifications the word "Contractor" shall mean the firm or corporation undertaking the execution of any installation work under the terms of these specifications.

1.2.5 Approved - In these specifications the word "approved" shall refer to the approval of the Engineer or his designated representative.

1.2.6 As Directed - In these specifications the words "as directed" shall refer to the directions to the Contractor from the Owner or his designated representative.

2.0 GENERAL CONDITIONS

2.1 The Contractor shall furnish all labor, material and equipment and perform all work and services except those set out and furnished by the Owner, necessary to complete in a satisfactory manner the site preparation, excavation, filling, compaction, grading as shown on the plans and as described therein. This work shall consist of all mobilization clearing and grading, grubbing, stripping, removal of existing material unless otherwise stated, preparation of the land to be filled, filling of the land, spreading and compaction of the fill, and all subsidiary work necessary to complete the grading of the cut and fill areas to conform with the lines, grades, slopes, and specifications. This work is to be accomplished under the observation of the Owner or his designated representative.

2.2 Prior to bidding the work, the Contractor shall examine, investigate and inspect the construction site as to the nature and location of the work, and the general and local conditions at the construction site, including without limitation, the character of surface or subsurface conditions and obstacles to be encountered on and around the construction site and shall make such additional investigation as he may deem necessary for the planning and proper execution of the work.

If conditions other than those indicated are discovered by the Contractor, the Owner shall be notified immediately. The material which the Contractor believes to be a changed condition shall not be disturbed so that the owner can investigate the condition.

2.3 The construction shall be performed under the direction of the Engineer.

2.4 All aspects of the structure design and site layout including foundations, backfill, end treatments and necessary scour consideration shall be performed by the Engineer.

Any installation guidance provided herein shall be endorsed by the Engineer or superseded by the Engineer's plans and specifications.

II - ALUMINUM BOX CULVERT

1.0 GENERAL

1.1 Manufacturer shall fabricate the aluminum box culvert as shown on the plans. Fabrication shall conform to the requirements of ASTM B-864 and shall consist of plates, ribs, and appurtenant items.

Plate thickness, rib spacing, end treatment and type of invert and foundation shall be as indicated on the plans. All manufacturing processes including corrugating, punching, curving and required galvanizing shall be performed within the United States of America.

1.2 The contractor shall verify all field dimensions and conditions prior to ordering materials.

2.0 DIMENSIONS

2.1 The proposed structure shall be an ALUMINUM BOX CULVERT with the following dimensions:

Span: 31'-5"	Rise: 7'-3"	Loading: HL-93
Haunch Gage: 0.15	Crown Gage: 0.15	Min. Cover: 2'-0"
Haunch Rib Type: TYPE VI	Crown Rib Type: TYPE VI	Max. Cover: 3'-0"
Haunch Rib Spacing: 9"	Crown Rib Spacing: 18"	

2.2 All plan dimensions on the contract drawings are measured in a true horizontal plan unless otherwise noted.

3.0 ASSEMBLY AND INSTALLATION

3.1 Bolts and nuts shall conform to the requirements of ASTM A-307 or ASTM A-449. The box culvert shall be assembled in accordance with the plate layout drawings provided by the manufacturer and per the manufacturer's recommendations.

Bolts shall be tightened using an applied torque of between 100 and 150 ft.-lbs.

3.2 The box culvert shall be installed in accordance with the plans and specifications, the manufacturer's recommendations, and AASHTO Standard Specification for Highway Bridges - Section 26 Division II - Construction.

3.3 Trench excavation shall be made in embankment material that is structurally adequate. The trench width shall be shown on the plans. Poor quality in situ embankment material must be removed and replaced with suitable backfill as directed by the Engineer.

3.4 Bedding preparation is critical to both structure performance and service life. The bed should be constructed to uniform line and grade to avoid distortions that may create undesirable stresses in the structure and/or rapid deterioration of the roadway. The bed should be free of rock formations, protruding stones, frozen lumps, roots, and other foreign matter that may cause unequal settlement.

3.5 Bedding shall provide a minimum of 4,000 psf bearing capacity. Foundation details for bearing capacity less than 4,000 psf shall be approved by the Engineer.

3.6 The structure shall be assembled in accordance with the Manufacturer's instructions. All plates shall be unloading and handled with reasonable care. Plates shall not be rolled or dragged over gravel rock and shall be prevented from striking rock or other hard objects during placement in trench or on bedding.

When installed on a full invert or on flexible footing pads, assembly of the invert or footing pads shall start at the downstream end. Circumferential seam laps shall shingle over the top of the downstream plates as assembly progresses upstream. Whether the box culvert is installed on a concrete footing, full metal invert, or flexible footing pad, assembly of the structure shell shall start at the upstream end. Downstream rings of plates shall be assembled outside of the upstream rings. (Circumferential seams are shingled downstream when viewed from the inside of the shell).

3.7 The structure shall be backfilled using clean well graded granular material that meets the requirements for soil classifications A-1, A-2-4, A-2-5 or A-3 modified to be more select than AASHTO M-145. See the information at the right of this sheet.

Backfill must be placed symmetrically on each side of the structure in 6 to 8 inch loose lifts. Each lift shall be compacted to a minimum of 90 percent density per AASHTO T-180

3.8 Construction loads that exceed highway load limits are not allowed to cross the structure without approval from the Engineer.

Normal highway traffic is not allowed to cross the structure until the structure has been backfilled and paved. If the road is unpaved, cover allowance to accommodate rutting shall be as directed by the Engineer.

GROUP CLASSIFICATION	A-1	A-3	A-2-4	A-2-5
Sieve Analysis Percent Passing				
No. 10 (2.000 mm)		----	----	----
No. 40 (0.425 mm)	50 max.	51 max.	----	----
No. 100 (0.150 mm)	----	----	50 max.	50 max.
No. 200 (0.075 mm)	25 max.	10 max.	20 max.	20 max.
Atterberg Limits for Fraction Passing No., 40 (0.425 mm)				
Liquid Limits	----	----	40 max.	41 max.
Plasticity Index	6 max.	Non Plastic	10 max.	10 max.
Usual Materials	Stone Fragment, Gravel and Sand	Sand	Silty or Clayey Gravel and Sand	

NOTE: Atterberg Limits are modified to provide material that are primarily granular

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PROPOSAL
DRAWING

CULVERT REPLACEMENT - MONKTON VT

NORTH FERRISBURGH, VT

Project No.:	Seq No.:	Date:
777264	010	10/27/2023
Designed: GR	Drawn:	
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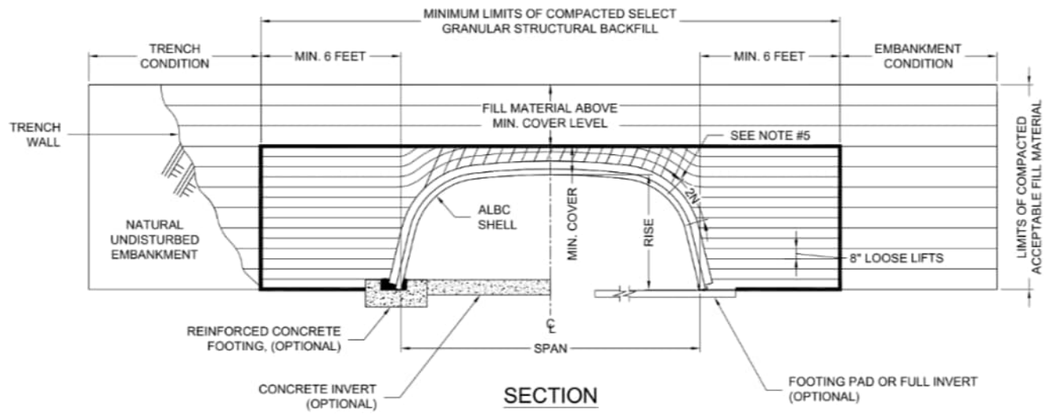
Sheet No.: 6 OF 7		



SECTION

SELECT GRANULAR STRUCTURAL BACKFILL LIMITS.

INITIAL LIFTS OVER THE CROWN OF STRUCTURE AS INDICATED BY SHADED AREA TO BE COMPACTED TO REQUIRED DENSITY WITH HAND OPERATED EQUIPMENT OR WITH LIGHTWEIGHT(D-4 OR LIGHTER) EQUIPMENT.

NOTES:

1. TRENCH WIDTH (OTHER THAN 6 FEET SHALL BE BY DIRECTION OF THE ENGINEER.
2. ALL SELECT GRANULAR BACKFILL TO BE PLACED IN A BALANCED TRENCH IN THIN LIFTS 8" LOOSE TYPICALLY AND COMPACTED TO 90 PERCENT DENSITY PER AASHTO T-180.
3. COMPLETE AND REGULAR MONITORING OF THE ALUMINUM BOX CULVERT STRUCTURE IS NECESSARY DURING THE ENTIRE BACKFILL PROCESS TO AT LEAST THE MINIMUM COVER LEVEL.
4. PREVENT DISTORTION OF SHAPE AS NECESSARY BY VARYING COMPACTION METHODS AND EQUIPMENT.
5. PLACE SELECT GRANULAR BACKFILL IN RADIAL LIFTS ON APPROXIMATELY 2:1 LIFTS ABOVE THE HAUNCH INDICATED CHANGE.

ADDITIONAL SELECT GRANULAR STRUCTURAL BACKFILL NOTES:

SATISFACTORY BACKFILL MATERIAL, PROPER PLACEMENT, AND COMPACTION ARE KEY FACTORS IN OBTAINING MAXIMUM STRENGTH AND STABILITY.

THE BACKFILL MATERIAL SHOULD BE FREE OF ROCKS, FROZEN LUMPS, AND FOREIGN MATERIAL THAT COULD CAUSE HARD SPOTS OR DECOMPOSE TO CREATE VOIDS. BACKFILL MATERIAL SHOULD BE WELL GRADED GRANULAR MATERIAL THAT MEETS THE REQUIREMENTS OF AASHTO M-145 FOR SOIL CLASSIFICATIONS A-1, A-2-4 OR A-2-5. *SEE THE STRUCTURAL PLATE BACKFILL GROUP CLASSIFICATION TABLE ON THIS SHEET.* BACKFILL MUST BE PLACED SYMMETRICALLY ON EACH SIDE OF THE STRUCTURE IN 8" LOOSE LIFTS. EACH LIFT IS TO BE COMPACTED TO A MINIMUM OF 90% DENSITY PER AASHTO T-180.

A HIGH PERCENTAGE OF SILT OR FINE SAND IN THE NATIVE SOILS SUGGESTS THE NEED FOR A WELL GRADED GRANULAR BACKFILL MATERIAL TO PREVENT SOIL MIGRATION. IF THE PROPOSED BACKFILL IS NOT A WELL GRADED GRANULAR MATERIAL, A NON-WOVEN GEOTEXTILE FILTER FABRIC SHALL BE PLACED BETWEEN THE SELECT BACKFILL AND THE IN SITU SOIL.

DURING BACKFILL, ONLY LIGHTWEIGHT TRACKED VEHICLES (D-4 OR LIGHTER) SHOULD BE NEAR THE STRUCTURE AS FILL PROGRESSES ABOVE THE CROWN AND TO THE FINISHED GRADE. THE ENGINEER AND CONTRACTOR ARE CAUTIONED THAT THE MINIMUM COVER MAY NEED TO BE INCREASED TO HANDLE TEMPORARY CONSTRUCTION VEHICLE LOADS (HEAVIER THAN D-4).

STRUCTURAL PLATE BACKFILL GROUP CLASSIFICATION, REFERENCE AASHTO M-145				
GROUP CLASSIFICATION	A-1-a	A-1-b	A-2-4	A-2-5
Sieve Analysis Percent Passing				
No. 10 (2.000 mm)	50 max.	---	---	---
No. 40 (0.425 mm)	30 max.	50 max.	---	---
No. 200 (0.075 mm)	15 max.	25 max.	35 max.	35 max.
Atterberg Limits for Fraction Passing No. 40 (0.425 mm)				
Liquid Limits	---	---	40 max.	41 min.
Plasticity Index	6 max.	6 max.	10 max.	10 max.
Usual Materials	Stone Fragment, Gravel and Sand		Silty or Clayey Gravel and Sand	

Reference the most current version of ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), for comparable soil groups.

1.0 STANDARDS AND DEFINITIONS

1.1 STANDARDS - All standards refer to the current ASTM / AASHTO edition unless otherwise noted.

1.1.1 ASTM B864 "Standard Specification for Corrugated Aluminum Box Culverts" (AASHTO Designation M-219).

1.1.2 AASHTO Standard Specification for Highway Bridges - Section 12 Division I - Design, AASHTO LRFD Bridge Design Specifications Section 12.

1.1.3 AASHTO Standard Specification for Highway Bridges - Section 26 Division II - Construction, AASHTO LRFD Bridge Construction Specifications - Section 26. ASTM B789, Standard Practice for Installing Corrugated Aluminum Structural Plate Pipe.

1.2 DEFINITIONS

1.2.1 Owner - In these specifications the word "Owner" shall mean ##########.

1.2.2 Engineer - In these specifications the word "Engineer" shall mean the Engineer of Record or Owner's designated engineering representative.

1.2.3 Manufacturer - In these specifications the word "Manufacturer" shall mean CONTECH ENGINEERED SOLUTIONS 800-338-1122 ##########.

1.2.4 Contractor - In these specifications the word "Contractor" shall mean the firm or corporation undertaking the execution of any installation work under the terms of these specifications.

1.2.5 Approved - In these specifications the word "approved" shall refer to the approval of the Engineer or his designated representative.

1.2.6 As Directed - In these specifications the words "as directed" shall refer to the directions to the Contractor from the Owner or his designated representative.

2.0 GENERAL CONDITIONS

2.1 Any installation guidance provided herein shall be endorsed by the engineer, discrepancies herein are governed by the Engineer's plans and specifications.

2.2 The Contractor shall furnish all labor, material and equipment and perform all work and services except those set out and furnished by the Owner, necessary to complete in a satisfactory manner the site preparation, excavation, filling, compaction, grading as shown on the plans and as described therein. This work shall consist of all mobilization clearing and grading, grubbing, stripping, removal of existing material unless otherwise stated, preparation of the land to be filled, filling of the land, spreading and compaction of the fill, and all subsidiary work necessary to complete the grading of the cut and fill areas to conform with the lines, grades, slopes, and specifications. This work is to be accomplished under the observation of the Owner or his designated representative.

2.3 Prior to bidding the work, the Contractor shall examine, investigate and inspect the construction site as to the nature and location of the work, and the general and local conditions at the construction site, including without limitation, the character of surface or subsurface conditions and obstacles to be encountered on and around the construction site and shall make such additional investigation as he may deem necessary for the planning and proper execution of the work.

If conditions other than those indicated are discovered by the Contractor, the Owner shall be notified immediately. The material which the Contractor believes to be a changed condition shall not be disturbed so that the owner can investigate the condition.

2.4 The construction shall be performed under the direction of the Engineer.

2.5 All aspects of the structure design and site layout including foundations, backfill, end treatments and necessary scour consideration shall be performed by the Engineer.

3.0 ASSEMBLY AND INSTALLATION

3.1 Bolts and nuts shall conform to the requirements of ASTM A307 and/or ASTM A449. The box culvert structure shall be assembled in accordance with the plate layout drawings provided by the Manufacturer and per the Manufacturer's recommendations.

Bolts shall be tightened using an applied torque of between 100 and 150 ft.-lbs.

3.2 The box culvert structure shall be installed in accordance with the plans and specifications, the Manufacturer's recommendations, and AASHTO Standard Specification for Highway Bridges - Section 26 Division II - Construction/AASHTO LRFD Bridge Construction Specifications - Section 26.

3.3 Trench excavation shall be made in embankment material that is structurally adequate. The trench width shall be shown on the plans. Poor quality in situ embankment material must be removed and replaced with suitable backfill as directed by the Engineer.

3.4 Aluminum Box Culvert designs require a minimum allowable soil-bearing pressure of 4,000 psf. Lower bearing capacities may be accommodated with a site specific design for an aluminum foundation or a concrete footing.

If the Engineer determines the natural foundation is inadequate to support the structure's backfill, the poor material shall be excavated, removed and replaced to a suitable depth with competent material.The specific depth of excavation required may be reduced by utilizing a geosynthetic reinforced foundation as designed by a qualified geotechnical engineer. For additional information contact your local Contech representative.

3.5 A metal or concrete foundation is required. When a metal foundation is used, the soil bedding requires a minimum of 6 inches of loose granular material with a maximum particle size of one half the corrugation depth. The proper width of the bedding material required shall conform to the project plans and specifications.

Bedding preparation is critical to both structure performance and service life. The bedding should be constructed to uniform line and grade to avoid distortions that may create undesirable stresses in the structure and/or rapid deterioration of the roadway. The bed should be free of rock formations, protruding stones, frozen lumps, roots, and other foreign matter that may cause unequal settlement.

3.6 The structure shall be assembled in accordance with the Manufacturer's instructions. All plates shall be unloaded and handled with reasonable care. Plates shall not be rolled or dragged over gravel rock and shall be prevented from striking rock or other hard objects during placement in trench or on bedding.

When installed on a full invert or on flexible footing pads, assembly of the invert or footing pads shall start at the downstream end. Circumferential seam laps shall shingle over the top of the downstream plates as assembly progresses upstream. Whether the box culvert is installed on a concrete footing, full metal invert, or flexible footing pad, assembly of the structure shell shall start at the upstream end. Downstream rings of plates shall be assembled outside of the upstream rings (Circumferential seams are shingled downstream when viewed from the inside of the shell).

3.7 The structure shall be backfilled using clean well graded granular material that meets the requirements for soil classifications A-1, A-2-4 or A-2-5 per AASHTO M-145. See the structural plate backfill group classification table on this sheet.

Backfill must be placed symmetrically on each side of the structure in 8 inch loose lifts. Each lift shall be compacted to a minimum of 90 percent density per AASHTO T-180.

3.8 Standard highway loads that meet the permissible design load limits for an Aluminum Box Culvert are not allowed on the structure until it is backfilled completely and pavement is in place.

The addition of temporary soil for heavy construction loads is not feasible or permissible for Aluminum Box Culverts. By design, these structures are limited in the range of permissible fill heights and live loads.

Heavy construction loads that exceed that of the particular highway live load design limits are not allowed on Aluminum Box Culverts without approval from the Engineer.

3.9 If an aluminum headwall and/or wingwall system is specified, the select granular structural backfill shall extend limits past the dead man anchor system. Contact the Engineer if stiff material or rock is encountered where the wingwalls and deadmen are to be installed.

STRUCTURES 88-143

PRELIMINARY
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